4.6 Alternative 2 Analysis

The goal of Alternative 2 is to have a more aggressive harvesting policy while preventing overfishing. This alternative is described in detail in Section 2.6.3.

4.6.1 Target Groundfish Species Analysis

This section examines the potential direct, indirect, and cumulative effects that the implementation of Alternative 2 is expected to have on the target groundfish species. The potential effects of two policy "bookends" are analyzed, FMP 2.1 and FMP 2.2. These represent the policy boundaries of Alternative 2. As actually implemented, Alternative 2 could include policy measures anywhere within the range between the two bookends. The impact analyses start with the baseline (2002) status of the BSAI and GOA target groundfish stocks described in Section 3.5.1, including past trends that are likely to persist into the foreseeable future. Then, a computer-based analytic model is used to project how specific characteristics of the target groundfish stocks would respond directly and indirectly to management actions under each FMP. These projections from the model are the predicted direct and indirect effects (impacts) of the FMP on the target groundfish stocks. Section 4.1.5 describes the analytic model and explains how it is applied.

The model output for each target groundfish stock is defined in terms of collected data and calculated measures that are standards used by fisheries managers to regulate the number of fish removed from the sea so that the fisheries will be sustainable over the long-term. These data and measures include the fishing mortality rate (F), the overfishing level (OFL), total and spawning biomass levels (B), the minimum stock size threshold (MSST), maximum sustainable yield (MSY), mean age of the stock in years, and the sex ratio of the stock (number of males compared to number of females). As discussed in the following subsections, relevant data are not always available for all stocks. When data gaps prevent application of the model to a specific stock, the projected direct or indirect effect is evaluated as unknown (U).

Each target groundfish stock is modeled with respect to the following direct and indirect effects:

Direct Effects

<u>Fishing Mortality</u>: This is the rate at which the stock is depleted by direct mortality imposed by removing the fish from the sea.

<u>Change in Biomass Level</u>: This is the change over time in the biomass of the stock, as measured in metric tons (mt). Two measures are used: total biomass, which is the estimated biomass of the entire stock, and spawning biomass, which is the estimated biomass of all of the spawning females in the stock.

<u>Spatial/Temporal Concentration of Catch</u>: This is the degree to which the fishery will concentrate in a particular geographic area during a particular period of time each season. This pattern in space and time can affect fishing mortality and can also influence habitat suitability for spawning, rearing, and feeding.

Direct and/or Indirect Effects

<u>Habitat Suitability</u>: This is the degree to which habitat has the right characteristics to support the target stock at one or more life-history stages (spawning, rearing of juveniles, availability of food at all stages, availability

of refuge areas to allow escape from predators at all stages). Habitat suitability can be affected directly, for example by mechanical damage from bottom trawling, or influenced indirectly, for example by the gradual depletion of corals that provide hard substrate.

Prey Availability: This is the extent to which prey species are present in the environment and available as food to the target stock. Like habitat suitability, this measure can be affected directly, for example by the direct removal of prey species by the fishery, or indirectly, for example by a change in the structure of the food web.

To determine their probable significance, the projected direct and indirect effects in each of the impact categories listed above are evaluated against significance criteria. The criteria are designed to be relevant and meaningful in terms of the target groundfish stocks. Each significance criterion includes a threshold value above (or below) which the projected effect would be considered significant. Each criterion also includes a definition of what would constitute a beneficial (positive, +) or adverse (negative, -) effect. The possible evaluations are significant and beneficial (S+), insignificant (I), significant and adverse (S-), and unknown (U). Evaluations of conditionally significant beneficial or adverse (CS + or -) are not made for projected direct and indirect effects on target groundfish species, because the model can show only whether the significance threshold is or is not exceeded. The significance criteria used for the target groundfish stocks are presented in Appendix A, Table 4.1-1.

Each of the following subsections presents the model results and rationale for the expected direct and indirect effects of FMPs 2.1 and 2.2 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.6-1. Following the direct and indirect effects discussions on each stock, the expected cumulative effects on that stock are evaluated and discussed. The evaluation of potential cumulative effects builds on the direct and indirect effects evaluations as a starting point, and then brings in persistent past effects as well as reasonably foreseeable future natural events and human activities external to fisheries management. The cumulative effects assessment method uses the same impact categories and significance criteria discussed above for direct and indirect effects. This method is described further in Section 4.1.4.

4.6.1.1 Pollock

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA pollock for each of the bookends under Alternative 2. Numerous fishery management actions have been implemented that affect the pollock fisheries in the EBS and GOA. These actions are described in more detail in Sections 3.5.1.1 and 3.5.1.15 of this Programmatic SEIS. Pollock is managed as separate stocks in the BSAI and GOA, and falls under Tier 1 in both the BSAI and GOA groundfish FMPs.

Direct/Indirect Effects of FMP 2.1

FMP 2.1 includes the following features:

- The ABC is increased to be equivalent to the OFL level, and the F_{OFL} fishing rate is not lowered for stock sizes below $B_{40\%}$.

- The BSAI optimum yield range of 1.4 - 2.0 million mt is removed, and the optimum yield is set to the sum of the individual species OFL levels.

- PSC limits and bycatch limits are removed.

- Trawl closure areas and gear restrictions are removed.

- Fishing is allowed in current closed areas, such as Walrus Island closures, red king crab savings area, Bogoslof area, Pribilof Island closure, and nearshore Bristol Bay closure.

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 2.1, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 9.6 million mt in 2005, then stabilize to about 10.0 million mt. The 2003-2007 average total biomass is 10.2 million mt. This reduction in biomass under FMP 2.1 is expected to have a significantly adverse impact on the EBS pollock stock.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Given that under FMP 2.1 directed fishing for pollock in this region is allowed, the expectation is that the stock will remain stable or decrease in the future. A similar pattern is expected for the Bogoslof Island (however, catch data from this region were unavailable for inclusion in the projection analysis).

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,070,000 mt by 2007 (Table H.4-23 of Appendix H). The average biomass over this period is expected to be 941,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels. Thus, the effects of FMP 2.1 on the GOA pollock stock are considered to be insignificant.

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 of Appendix H and Figure H.4-1 of Appendix H. Under FMP 2.1, projections indicate that EBS pollock spawning biomass will decrease to about 60 percent of the 2002 level by 2007. The projected average for 2003-2007 is 2.43 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since under FMP 2.1 these areas are expected to have relatively large increases in fishing (compared to 2002), we expect the spawning stock size to be stable or decrease in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 171,000 mt by 2007 under FMP 2.1. This is below the estimated B_{msy} level of 210,000 mt with an average over 2003-2007 of 148,300 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H and Figure H.4-12 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 140 percent and equal the $F_{35\%}$ value of 0.448 for the period 2003-2007 (Table H.4-1 of Appendix H). Fishing mortality for the Bogoslof and Aleutian Islands region is expected to increase to the natural mortality rate of 0.3 under FMP 2.1 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections increasing to the $F_{35\%}$ levels of 0.350 for all projection years (Table H.4-23 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 involves the resumption of fishing in a number of areas currently closed, and these areas are largely in the Aleutian Islands. It is unknown how changes in spatial/temporal concentrations will affect pollock stocks. Since pollock are relatively low-valued groundfish species, the viability of pollock fisheries may be sensitive to changes in pollock densities and concentrations. However, the concentration of the harvest is not expected to be of a magnitude to sufficiently alter the genetic structure or reproductive success of either the EBS or GOA populations.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL, removing the buffer between these two harvest regulations. Model projections of future catches of EBS and GOA pollock are at or below the OFL level from 2003 to 2008. For GOA pollock, the stock is expected to be above the MSST for the years 2003-2007. The EBS pollock stock appears to be above the MSST during the years 2003-2005, but for 2006 and 2007, the stock may be declared as below the MSST and require separate management measures for a rebuilding plan (since a 10-year projection from the 2006 and 2007 years result in spawning biomass estimates that are below the B_{msy} level in 2016 and 2017).

Age and Size Composition

Under FMP 2.1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.32 years (Table H.4-1 of Appendix H). This compares with a mean age in the equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 2.77 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+) (Table H.4-23 of Appendix H).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under FMP 2.1. However, since the catch levels are much higher than the 2002 levels, this assertion becomes more tenuous.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.1.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. Since the catch is much higher than in 2002, it may cause significant qualitative changes in predator-prey interactions as a result of actions taken under FMP 2.1 (for the period 2003-2007). However, changes in prey availability are not expected to jeopardize the ability of either the EBS or GOA pollock stocks to sustain at or above the MSST. Therefore, FMP 2.1 would have an insignificant effect on EBS and GOA pollock through prey availability.

Summary of Effects of FMP 2.1 on Pollock

Although the ABC and OFL levels for pollock are equivalent under FMP 2.1, the F_{OFL} is not reduced for lower stock sizes, and the harvest of pollock under FMP 2.1 is increased relative to recent levels, the fishing rates on pollock drops below the B_{msy} reference point. This is substantially different than the pattern in recent years (and the baseline 2002 data). It could be argued that these levels are within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. However, the direct and indirect effects of FMP 2.1 on EBS pollock biomass are considered significant (Table 4.6-1).

Cumulative Effects of FMP 2.1

External effects and the resultant cumulative effects associated with FMP 2.1 are shown in Tables 4.5-1 and 4.5-2.

EBS Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 2.1 (see Section 4.6.1.1).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Removals of pollock occur in the Russian pollock fishery, and the catch is not accounted for in the annual harvest rates set for the US fishery. Therefore, the removals can be considered a potential adverse effect on fishing mortality. Catch and bycatch of pollock in the State of Alaska pollock fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of EBS pollock, and is insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be significantly adverse under FMP 2.1 (see Section 4.6.1.1).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the Russian and State of Alaska pollock fisheries. However, any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effects for change in biomass is identified under FMP 2.1. The effect is determined to be significantly adverse. Under this FMP, a large percentage reduction in biomass over the period 2003-2007 is predicted. The pollock stock is predicted to fall below MSST over the modeled period. The external factors are not expected to improve or mitigate the effect. Therefore the cumulative effect is judged to be significantly adverse.

<u>Spatial/Temporal Concentration of Catch</u>

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of catch is considered to be insignificant under FMP 2.1 (see Section 4.6.1.1).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had a beneficial effect on pollock recruitment by reducing the adult pollock biomass, lingering beneficial effects are identified for change in reproductive success. In addition, past commercial whaling and sealing also removed large predators of pollock adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** The Russian and State of Alaska pollock fisheries are identified as having potential adverse contributions to changes in genetic structure. However, removals in these fisheries could have a potential beneficial effects on pollock recruitment by reducing the adult pollock biomass. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** The cumulative effect on pollock reproductive success and genetic variability is considered insignificant under FMP 2.1. The concentration of harvest by the groundfish fisheries in combination with external effects are not expected to be of sufficient magnitude to adversely effect this stock.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.1 would have insignificant effects on pollock prey availability (see Section 4.6.1.1).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species are potentially adverse or beneficial; a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries are determined to have potential adverse contributions since bycatch and catch of forage species is likely to occur.

- **Cumulative Effects.** Cumulative effects are identified for prey availability, and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, as described in Section 4.6.1.1 FMP 2.1 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS pollock stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the Russian and State of Alaska fisheries since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its effect on the EBS pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 2.1 (see Section 4.6.1.1 Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** Catch and bycatch of pollock in the State of Alaska pollock fisheries and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1, are identified for mortality of GOA pollock, but the effects are judged to be insignificant for the FMP. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 2.1. As modeled under the FMP, the age 2-10+ biomass of GOA pollock is expected to increase (see Table H.4-23 of Appendix H). The increase is anticipated primarily because recruitment is expected to improve from recent low levels.

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.15), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the State of Alaska pollock and shrimp fisheries. However, any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under the FMP 2.1; however, the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized. Therefore, the effects of FMP 2.1 on GOA pollock through the change in biomass are considered insignificant.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; although, it is not possible to predict exactly how the pattern will change. However, the concentration of harvest by the groundfish fisheries is not expected to be of sufficient magnitude to adversely effect this stock. Therefore, FMP 2.1 is considered to have insignificant effects on GOA pollock through genetic structure and reproductive success.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.15) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** State of Alaska pollock fisheries and the State of Alaska shrimp fishery are identified as potential adverse contributors. However, these fisheries are unlikely to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** The cumulative effect on pollock reproductive success and genetic variability is considered insignificant under FMP 2.1. The concentration of harvest by the groundfish fisheries in combination with external effects are not expected to be of sufficient magnitude to adversely effect this stock. Therefore, the effects of FMP 2.1 on GOA pollock through the change in reproductive success and genetic variability are considered insignificant.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for EBS pollock, climate changes and regime shifts could have potentially adverse or beneficial effects on pollock prey species. The other fisheries are determined to be potential adverse contributors. Since bycatch and catch of forage species used by pollock is unlikely to occur.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the FMP, and the combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST. Therefore, the cumulative effect of FMP 2.1 on GOA pollock through prey availability is considered insignificant.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stocks include past foreign, JV, and State of Alaska, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska pollock and shrimp fisheries since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would be either adverse or beneficial as described for EBS pollock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, the effects on the GOA pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

Direct/Indirect Effects of FMP 2.2

FMP 2.2 is less aggressive than FMP 2.1, and is similar to FMP 1 in many respects with the following exceptions:

- Current bycatch and incidental catch restrictions are removed.

- The BSAI optimum yield range of 1.4 - 2.0 million mt is removed, and the optimum yield is set to the sum of the individual species ABC levels.

<u>Total Biomass</u>

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H Under FMP 2.2, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 10.3 million mt in 2005, then increase to about 10.9 million mt by 2007. The 2003-2007 average total biomass is 10.8 million mt. Because the EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years, the effects of FMP 2.2 on EBS pollock through the change in biomass is insignificant.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. If under FMP 2.2, directed fishing for pollock in this region is allowed, the expectation is that the stock will remain stable or decrease in the future. A similar pattern is expected for the Bogoslof Island.

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,240,000 mt by 2007 (Table H.4-23 of Appendix H). The average biomass over this period is expected to be 1,040,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels. Thus, the effects of FMP 2.2 on GOA pollock through the change in biomass is considered insignificant.

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 Appendix H. Under FMP 2.2, projections indicate that EBS pollock spawning biomass will decrease to about 67 percent of the 2002 level by 2007. The projected average for 2003-2007 is 2.73 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since under FMP 2.2 these areas may have developed fisheries, we expect the spawning stock size to remain stable or decrease in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 240,000 mt by 2007 under FMP 2.2. This is above the estimated B_{msy} level of 210,000 mt although the average from 2003-2007 is 188,000 mt. Model projections of future levels are shown in Table H.4-23 Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 69 percent and average 0.315 for the period 2003-2007. These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years. The proportion of SPR conserved under these mortality rates is 40 percent in 2003. The average implied SPR rate of fishing from 2003-2007 is 42 percent, well below the value estimated for 2002 (indicating a higher fishing mortality rate for this FMP) (Table H.4-1 of Appendix H). Thus, the effect of FMP 2.2 on EBS pollock through mortality is considered insignificant. Fishing mortality for the Bogoslof and Aleutian Islands region may increase to 75 percent of natural mortality under FMP 2.2 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.126 in 2003 followed by increases to 0.172 by 2007. The values for $F_{35\%}$ and $F_{40\%}$ are 0.350 and 0.294, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 60 percent for the period 2003-2007. This fishing mortality rate pattern is due to the fact that under this FMP, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$ (Table H.4-23 of Appendix H). Thus, the effect of FMP 2.2 on GOA pollock through mortality is considered insignificant.

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (Jan 20-March). Under FMP 2.2, an average of 1.67 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial/temporal allocations as presented in Section 3.5.1.1. This concentration of harvest is not expected to be of sufficient magnitude to alter the genetic variability or reproductive success of the EBS pollock stock. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period.

In the GOA, pollock fishery in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.15. Under FMP 2.2, an average of 75,600 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 111,000 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. However, this concentration of harvest is not expected to be of sufficient magnitude to alter the genetic variability or reproductive success of the GOA pollock stock.

Status Determination

Under FMP 2.2, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For FMP 2.2, GOA pollock spawning biomass is below the B_{msy} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Age and Size Composition

Under FMP 2.2, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.43 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years (Table H.4-1 Appendix H). For GOA pollock the 2007 value is 3.07 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+) (Table H.4-23 of Appendix H).

Sex Ratio

In the models, the sex ratio of EBS and GOA pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under FMP 2.2 (for the period 2003-2007).

Summary of Effects of FMP 2.2 – Pollock

Because the EBS and GOA pollock are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 2.2 are considered insignificant. Fishing rates are lower than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Cumulative Effects of FMP 2.2 – EBS Pollock

While the internal modeling results change, the external effects and cumulative effects for FMP 2.2 in the EBS are the same as those discussed for FMP 1 and presented in Table 4.5-1. These effects are summarized below.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 2.2 (see Section 4.6.1.1 Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** As described for the FMP 2.1 cumulative effects section, removals of pollock occur in the Russian pollock fishery are considered to be a potential adverse contributor, while removals in the Alaska pollock fisheries are not considered to contribute to pollock mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of EBS pollock, but the effect is judged to be insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be insignificant under FMP 2.2 (see Section 4.6.1.1 Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects are the same as those described above for FMP 2.1 and include the Russian and State of Alaska pollock fisheries, and marine pollution.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified, and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.6.1.1 Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects under FMP 2.2 are identical to those discussed for FMP 2.1 and include lingering beneficial effects on reproductive success.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the Russian and State of Alaska pollock fisheries have the potential to cause adverse effects on genetic structure and potential beneficial effects on pollock recruitment by reducing the adult pollock biomass. Cannibalism-related declines in pollock recruitment have been observed at high pollock spawning biomasses (see Section 3.5.1.1). Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see Section 4.6.1.1). However, it is determined that the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species could have potential beneficial or potential adverse effects (see the cumulative effects discussion for FMP 2.1). On the other hand, marine pollution has been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see Section 4.6.1.1 Direct/Indirect Effects). However, it is determined that the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS pollock stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1) Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 adverse effects are possible from the Russian and State of Alaska fisheries, and marine pollution. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be either beneficial or adverse.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability, and the effects on the EBS pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, catch and bycatch of pollock in the State of Alaska pollock fisheries, and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Marine pollution is identified as having a potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of GOA pollock, and the effects are judged to be insignificant for the FMP. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 2.2 (see Section 4.6.1.1).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.15), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described in FMP 2.1, effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. Marine pollution is identified as having a potential adverse contribution to change in biomass, and climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified, and the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized. Therefore, the cumulative effect of FMP 2.2 on GOA pollock through the change in biomass is considered insignificant.

<u>Spatial/Temporal Concentration of Catch</u>
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; it is not possible to predict exactly how the pattern will change. However, for GOA pollock under FMP 2.2, the stock is expected to be above MSST for the years 2003-2007 (see Direct/Indirect Effects). Therefore, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.15) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the State of Alaska pollock fisheries and marine pollution are identified as potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration under FMP 2.2; however, the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized. Therefore, the cumulative effects of FMP 2.2 on GOA pollock through the change in genetic structure and reproductive success are insignificant.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see above). However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, climate changes and regime shifts could have potential adverse or beneficial effects on pollock prey species. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-2 are determined to be potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST. Therefore, the cumulative effect of FMP 2.2 on GOA pollock through the change prey availability is considered are insignificant.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see Direct/Indirect Effects). However, it is determined that the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stocks include past foreign, JV, and State of Alaska, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects**. Future external effects are possible from the State of Alaska pollock and shrimp fisheries since either of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would be either adverse or beneficial as described for EBS pollock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability, and the effect on the GOA pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

4.6.1.2 Pacific Cod

Pacific cod are managed under Tier 3a in the BSAI and GOA.

Direct/Indirect Effects of FMP 2.1

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-3 Appendix H. Under FMP 2.1, model projections indicate that total BSAI biomass is expected to increase to a value of 2,061,000 mt in 2003, then decrease to a value of 1,868,000 mt in 2007, with a 2003-2007 average value of 1,938,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 2.1, model projections indicate that total GOA biomass is expected to increase steadily to a value of 631,000 mt in 2007, with a 2003-2007 average value of 598,000 mt.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H and Figure H. 4-2 of Appendix H. Under FMP 2.1, model projections indicate that BSAI spawning biomass is expected to decrease steadily to a value of 346,000 mt in 2007, with a 2003-2007 average value of 373,000 mt. Projected spawning biomass dips below the B_{MSY} proxy value of 361,000 mt in 2006 and 2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-24 of Appendix H and Figure H. 4-13 of Appendix H. Under FMP 2.1, model projections indicate that GOA spawning biomass is expected to decrease to a value of 69,700 mt in 2006, then increase to a value of 71,700 mt in 2007, with a 2003-2007 average value of 74,800 mt. Projected spawning biomass dips below the B_{MSY} proxy value of 79,000 mt in 2004, 2005, 2006, and 2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-3 of Appendix H. Under FMP 2.1, model projections indicate that BSAI fishing mortality will increase to a value of 0.409 in 2003, then remain there through 2007, giving a 2003-2007 average of 0.409. This value is equal to the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for any value of biomass under this FMP.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-24 of Appendix H. Under FMP 2.1, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.421 in 2004, then decrease to a value of 0.417 in 2007, with a 2003-2007 average of 0.419. These values are equal to or slightly below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for any value of biomass under this FMP.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are equal to or below their respective OFLs in all years under FMP 2.1 (Table H.4-3 of Appendix H). The BSAI Pacific cod stock is projected to be above MSST in 2003-2006 but below MSST in 2007. The GOA Pacific cod stock is projected to be above MSST in 2003 but below MSST in 2004. Information from the projection model is insufficient to determine the status of GOA Pacific cod with respect to MSST in 2005-2007 under this FMP (Table H.4-24 of Appendix H).

Age and Size Composition

Under FMP 2.1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.6 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 2.1, the projected mean age of the GOA Pacific cod stock in 2008 is 2.7 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 on Pacific cod would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under this FMP.

Summary of Effects of FMP 2.1 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 2.1, both stocks are projected to fall below MSST at least once during the period 2003-2007, the biomass of both stocks is projected to be below $B_{40\%}$ throughout the period 2003-2007, the biomass of both stocks is expected to show an overall decrease during the period 2003-2007 and beyond, and all catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 2.1 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 2.1 on BSAI or GOA Pacific cod.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 2.1 on fishing mortality is rated insignificant, because the projection model indicates that fishing mortality would be less than or equal to the OFL throughout the period 2003-2007. However, the impact of FMP 2.1 on the biomass of the BSAI and GOA

Pacific cod stocks is rated significantly adverse, because the biomass of the BSAI Pacific cod stock is projected to fall below the MSST in 2007 and the GOA Pacific cod stock is projected to be below the MSST in 2004 (information from the projection model is insufficient to determine the status of GOA Pacific cod with respect to the MSST in 2005-2007 under this FMP).

The existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST. Furthermore, the impacts of spatial-temporal concentration on genetic structure under FMP 2.1 are expected to be not much greater than those of the existing concentration. However, because the BSAI and GOA Pacific cod stocks are projected to fall below their respective MSSTs at least once during the period 2003-2007 under FMP 2.1, the available evidence is insufficient to conclude whether changes in genetic structure due to spatial-temporal concentration of the catch under FMP 2.1 would materially impact either stock's ability to maintain itself at or above the MSST. Therefore, the magnitude of this effect is rated unknown for both stocks.

The existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST. Furthermore, the impacts of spatial-temporal concentration on reproductive success under FMP 2.1 are expected to be not much greater than those of the existing concentration. However, because the BSAI and GOA Pacific cod stocks are projected to fall below their respective MSSTs at least once during the period 2003-2007 under FMP 2.1, the available evidence is insufficient to conclude whether changes in reproductive success due to spatial-temporal concentration of the catch under FMP 2.1 would materially impact either stock's ability to maintain itself at or above the MSST. Therefore, the magnitude of this effect is rated unknown for both stocks.

The existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST. However, the level of groundfish harvest under FMP 2.1 is expected to be somewhat higher than the existing level and the BSAI and GOA Pacific cod stocks are projected to fall below their respective MSSTs at least once during the period 2003-2007 under FMP 2.1. Nevertheless, the fact that Pacific cod prey on many things besides groundfish makes it unlikely that changes in prey availability under FMP 2.1 would materially impact either stock's ability to maintain itself at or above the MSST. Therefore, the magnitude of this effect is rated insignificant for both stocks.

The existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST. Furthermore, the level of habitat disturbance under FMP 2.1 is expected to be not much greater than the existing level. However, because the BSAI and GOA Pacific cod stocks are projected to fall below their respective MSSTs at least once during the period 2003-2007 under FMP 2.1, the available evidence is insufficient to conclude whether changes in habitat suitability under FMP 2.1 would materially impact either stock's ability to maintain itself at or above the MSST. Therefore, the magnitude of this effect is rated unknown for both stocks (Table 4.6-1).

Cumulative Effects of FMP 2.1

For further information regarding persistent past effects listed below in the text and in the tables, see Sections 3.5.1.2 and 3.5.1.16. External effects and the resultant cumulative effects associated with FMP 2.1 are shown in Tables 4.5-3 and 4.5-4.

BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stock is insignificant under FMP 2.1 (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of BSAI Pacific cod, and is judged to be insignificant. Model projections indicate catch will be equal to, but not exceed the OFL for all years, and all catch and bycatch from external fisheries are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events are not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stock is expected to be significantly adverse under FMP 2.1 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified under FMP 2.1. The effect is judged to be significantly adverse. Due to the internal effects of the FMP, biomass of BSAI stock is projected to fall below the MSST in 2007. The additional mortality from external human controlled events will likely cause additional reduction in biomass.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1, the effects of the spatial/temporal distribution of catch on the genetic structure and reproductive success of the population are unknown (see Section 4.6.1.2 Direct/Indirect Effects).

- **Persistent Past Effects.** Paste effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries and subsistence use in the BSAI have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown. Evidence is insufficient to conclude whether the combined effects of the internal and external actions/events would impact the stock's ability to maintain itself at or above MSST.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of the FMP would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.1 would have insignificant effects on Pacific cod prey availability (see Section 4.6.1.2).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 levels of habitat disturbance may lead to changes in spawning or rearing success in the BSAI Pacific cod population. However, the evidence is insufficient to conclude that any changes that did occur would impact the stock's ability to sustain MSST. Therefore, the effect is rated as unknown (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stock include past foreign, JV, domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stock are unknown, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its significance on the BSAI Pacific cod stock is unknown.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under FMP 2.1 (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries, and State of Alaska groundfish fisheries are identified for the GOA Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries in the GOA, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of GOA Pacific cod, and the effect is judged to be insignificant. Model projections indicate catch will be equal to, but not exceed the OFL for all years, and all catch and bycatch from external fisheries are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stock is expected to be significantly adverse under FMP 2.1 (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stock. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery and the State of Alaska groundfish fisheries in the GOA. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified under FMP 2.1. The effect is judged to be significantly adverse. Due to the internal effects of the FMP, biomass of GOA stock is projected to fall below the MSST in 2004. The additional mortality from external human controlled events could cause additional reduction in biomass.

<u>Spatial/Temporal Concentration of Catch</u>
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1, the effects of the spatial/temporal distribution of catch on the genetic structure and reproductive success of the population are unknown (see direct/indirect discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, State of Alaska groundfish fisheries, and subsistence use in the GOA have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown. Evidence is insufficient to conclude whether the combined effects of the internal and external actions/events would impact the stock's ability to maintain itself at or above MSST.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of the FMP would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.1 would have insignificant effects on Pacific cod prey availability (see Section 4.6.1.2).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described in the discussion of the Bering Sea stock, climate changes and regime shifts on Pacific cod prey species in the GOA could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 levels of habitat disturbance may lead to changes in spawning or rearing success in the GOA Pacific cod population. However, the evidence is insufficient to conclude that any changes that did occur would impact the stock's ability to sustain MSST. Therefore, the effect is rated as unknown (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod stock include past foreign, JV, domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, State of Alaska groundfish fisheries, and climate changes and regime shifts (see Section 3.5.1.16). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described for the Bering Sea, impacts on habitat from climate changes and regime shifts on the GOA Pacific cod stock could be either beneficial or adverse. Marine pollution has been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its significance on the GOA Pacific cod stock is unknown since the effect of the FMP is unknown.

Direct/Indirect Effects of FMP 2.2 – BSAI Pacific Cod

All direct and indirect effects of FMP 2.2 on BSAI Pacific cod are expected to be insignificant, because the analytic model results indicate that none of the threshold values for the significance criteria in Appendix A, Table 4.1-1 would be reached.

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Under FMP 2.2, model projections indicate that total BSAI biomass is expected to increase to a value of 2,078,000 mt in 2004, then decrease to a value of 2,057,000 mt in 2006, then increase to a value of 2,072,000 mt in 2007, with a 2003-2007 average value of 2,065,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Under FMP 2.2, model projections indicate that total GOA biomass is expected to increase steadily to a value of 675,000 mt in 2007, with a 2003-2007 average value of 622,000 mt.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Under FMP 2.2, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 435,000 mt in 2005, then decrease to a value of 425,000 mt in 2007, with a 2003-2007 average value of 422,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Under FMP 2.2, model projections indicate that GOA spawning biomass is expected to decrease to a value of 79,100 mt in 2005, then increase to a value of 85,700 mt in 2007, with a 2003-2007 average value of 83,100 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Under FMP 2.2, model projections indicate that BSAI fishing mortality will increase to a value of 0.297 in 2004, then decrease to a value of 0.287 in 2007, with a 2003-2007 average of 0.293. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for stocks above $B_{40\%}$.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Under FMP 2.2, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.324 in 2003, then decrease to a value of 0.289 in 2005, then increase to a value of 0.312 in 2007, with a 2003-2007 average of 0.304. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.2, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under FMP 2.2. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007.

Age and Size Composition

Under FMP 2.2, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.7 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 2.2, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.2 on Pacific cod would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under this FMP.

Summary of Effects of FMP 2.2 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 2.2, both stocks are projected to remain above MSST throughout the period 2003-2007. The biomass of the BSAI stock is projected to be below $B_{40\%}$ in 2003 but above $B_{40\%}$ in 2004-2007, while the biomass of the GOA stock is projected to be below $B_{40\%}$ throughout the period 2003-2007. The biomass of the BSAI stock is expected to show an overall increase during the period 2003-2007 and beyond, while the biomass of the GOA stock is expected to show an overall decrease during the period 2003-2007 and beyond. All catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 2.2 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 2.2 on BSAI or GOA Pacific cod. Table 4.5-7 summarizes the effects of FMP 2.2 on Pacific cod stocks in the BSAI and GOA, respectively.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 2.2 on fishing mortality and biomass is rated insignificant, because the projection model indicates that fishing mortality would be less than the OFL and biomass would be above the MSST throughout the period 2003-2007.

Because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on genetic structure under FMP 2.2 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on reproductive success under FMP 2.2 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of groundfish harvest under FMP 2.2 is expected to be not much greater than the existing level, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of habitat disturbance under FMP 2.2 is expected to be not much greater than the existing level, the magnitude of this effect is rated insignificant for both stocks (Table 4.6-1).

Cumulative Effects of FMP 2.2 – BSAI Pacific Cod

For further information regarding past effects see Section 3.5.1.2. BSAI internal, external, and cumulative effects are depicted on Table 4.5-3.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stock is insignificant under FMP 2.2 (see direct/indirect effects discussion presented above).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, but they are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of BSAI Pacific cod, and the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stock is expected to be insignificant under FMP 2.2 (see Section 4.6.1.2).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect on the change in biomass is identified, and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the IPHC longline and State of Alaska crab fisheries, subsistence use in the BSAI, and marine pollution could contribute adversely to genetic changes and reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration, and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.2 would have insignificant effects on Pacific cod prey availability (see direct/indirect effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-3 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Because the level of habitat disturbance under the FMP is expected to be no greater than the existing level, the effect is rated as insignificant (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stock include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stock could be either beneficial or adverse and marine pollution could have an adverse effect on habitat.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability, and the combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST. Therefore, the effect of FMP 2.2 on BSAI Pacific cod through habitat suitability is considered insignificant.

GOA Pacific Cod

External effects and the resultant cumulative effects associated with FMP 2.2 are shown in Table 4.5-4.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stock. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 in the GOA, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries in the GOA, but are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of GOA Pacific cod, and the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stock is expected to be insignificant under FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.16), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery, and in the State of Alaska groundfish fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect on the change in biomass is identified and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized. Therefore, the cumulative effect of FMP 2.2 on GOA pollock through the change in biomass is considered to be insignificant.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment particularly in the GOA where the State of Alaska groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the IPHC longline and State of Alaska crab fisheries, subsistence use, and State of Alaska groundfish fisheries, and marine pollution all have the potential to cause adverse effects.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.2 would have insignificant effects on Pacific cod prey availability (see Direct/Indirect Effects).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 in the GOA, the effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-4 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is rated as insignificant (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.16). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA Pacific cod stock could be either beneficial or adverse and marine pollution has been identified as a potential adverse contributing factor.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST.

4.6.1.3 Sablefish

Sablefish are managed as one stock in the BSAI and GOA under Tier 3b; therefore, BSAI and GOA areas are discussed together in this section.

Direct/Indirect Effects of FMP 2.1

Direct/indirect effects are summarized in Table 4.6-1.

Catch/ABC

FMP 2.1 is projected to significantly increase average sablefish yield compared to the baseline. Higher yields are projected because a higher fishing rate ($F_{35\%}$) is used for F_{ABC}.

Total Biomass

FMP 2.1 is projected to have a significant impact on total biomass (age 2-31+) compared to the baseline. Fishing mortality is higher for this alternative (Tables H.4-11and H.4-30 of Appendix H). Total biomass is unchanged for this FMP rather than increasing as projected for alternatives that replicate baseline conditions.

Spawning Biomass

FMP 2.1 is projected to have a significantly adverse impact on spawning biomass compared to the baseline. Spawning biomass is projected to decrease by 2007, approaching some benchmarks that imply some risk to the reproductive success of the stock. Projected 2007 spawning biomass is 35 percent of the unfished value for this alternative, approaching the historic low spawning biomass (30 percent, 1975) and the lowest spawning biomass (34 percent, 1977) that produced above average year-classes (Sigler *et al.* 2002) (Tables H.4-11 and H.4-30 of Appendix H) and Figures H.4-9 and H.4-14 of Appendix H.

Fishing Mortality

Under FMP 2.1, the fishing mortalities imposed on the sablefish stock in the BSAI are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL. Fishing mortality is comparatively low because catch usually is less than ABC in the BSAI (Table H.4-11 of Appendix H). In contrast, the fishing mortalities imposed on the sablefish stock in the GOA are similar to the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Table H.4-30 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 2.1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. Although numerous current closed/restricted areas are repealed by FMP 2.1, these repeals little affect areas where adult sablefish are caught.

Status Determination

Under FMP 2.1, sablefish is not overfished but is projected to be approaching an overfished condition. Sablefish spawning biomass is projected to fall below B_{MSY} ($B_{35\%}$ for Tier 3 stocks) and remain there for at least a decade.

Age and Size Composition

FMP 2.1 is projected to have an insignificant impact on mean age compared to the baseline. The mean age decreases somewhat due to increased fishing mortality, but not enough to be classified as significant. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However sablefish migration is substantial enough to erase the effects of differential exploitation rates between the GOA and BSAI. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males: 60 females, based on sex ratio data collected during sablefish longline surveys. This FMP probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

FMP 2.1 would increase exploitation rates and so would increase any effects that additional fishing may have to decrease habitat suitability.

Predator-Prey Relationships

FMP 2.1 is projected to have a significant impact on total biomass (age 2-31+) compared to the baseline. Although total biomass doesn't change, fewer sablefish are projected for this FMP compared to alternatives that replicate baseline conditions. Thus this FMP is projected to have a significant effect on the amount of sablefish biomass that would be available to the ecosystem and the amount of predation that would be due to sablefish.

Cumulative Effects of FMP 2.1

External effects and the resultant cumulative effects associated with FMP 2.1 are depicted on Table 4.5-5. For further information regarding persistent past effects listed below in the text and in table, see the past/present effects analysis in Sections 3.5.1.3 and 3.5.1.17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 2.1 (see Section 4.6.1.3).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for Sablefish. Large removals of Sablefish occurred, particularly in the JV and domestic fisheries. Catches that were under reported during the late 1980s may have contributed to abundance declines in the 1990s (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Sablefish are predicted to continue in the IPHC longline fishery, and State of Alaska groundfish fishery, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels and do not add additional fishing mortality. Due the highly migratory nature, Canadian fisheries, fishing within Canadian waters could be harvesting sablefish considered to be part of the GOA population. These removals are not accounted for in the TAC setting process and can be considered as having a potential adverse contribution to the cumulative case. Likewise, marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to direct Sablefish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of sablefish, and is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the Sablefish stock is expected to be significantly adverse under FMP 2.1 (see Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of Sablefish and other past effects on biomass have been identified (see Sections 3.5.1.3 and 3.5.1.17), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Sablefish mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified. The effect is judged to be significantly adverse since the combination of internal and external factors is expected to sufficiently reduce the Sablefish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the State of Alaska directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska groundfish fisheries, and Canadian fisheries all have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population or affect recruitment. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of harvest and is considered to be insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Sablefish prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Sablefish prey species (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Sablefish prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Sections 3.5.1.3 and 3.5.1.17). Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Sablefish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish habitat suitability (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for Sablefish include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Sections 3.5.1.3 and 3.5.1.17). Past fishing for Sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described for prey availability impacts on habitat from climate changes and regime shifts on the Sablefish stock could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability and are considered insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is jeopardized.

Direct/Indirect Effects of FMP 2.2

Direct/indirect effects are summarized in Table 4.6-1.

Catch/ABC

FMP 2.2 is projected to significantly increase average sablefish catch, but not ABC, compared to the baseline. Yields likely increase because fisheries where sablefish are caught as bycatch can catch the full ABC. For example, sablefish primarily are caught in a directed fishery, but also as bycatch in fisheries such as Greenland turbot in the Bering Sea. Setting the OY to the sum of the ABCs likely increases the amount of sablefish caught as bycatch.

Fishing Mortality

Under FMP 2.2, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Tables H.4-11and H.4-30 of Appendix H).

Total Biomass

FMP 2.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. Fishing mortality is higher for FMP 2.2, but catches remain relatively small compared to total biomass, so that the increased catches have an insignificant impact on total biomass (Tables H.4-11 and H.4-30 of Appendix H).

Spawning Biomass

FMP 2.2 is projected to have an insignificant impact on spawning biomass compared to the baseline. Fishing mortality is higher for FMP 2.2, but catches remain relatively small compared to spawning biomass, so that the increased catches have an insignificant impact on spawning biomass (Tables H.4-11 and H.4-30 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 2.2 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. FMP 2.2 closed areas are the same as baseline.

Status Determination

Under FMP 2.2, sablefish is not overfished nor approaching an overfished condition.

Age and Size Composition

FMP 2.2 is projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However sablefish migration is substantial enough to erase the effects of differential exploitation rates between the GOA and BSAI. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males: 60 females, based on sex ratio data collected during sablefish longline surveys. This FMP probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

FMP 2.2 would increase exploitation rates and so would increase any effects that additional fishing may have to decrease habitat suitability.

Predator-prey Relationships

FMP 2.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline, so this FMP should have an insignificant effect on the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish.

Cumulative Effects of FMP 2.2

External effects and the resultant cumulative effects associated with FMP 2.2 are depicted on Table 4.5-5. For further information regarding persistent past effects listed below in the text and in table, see the past/present effects analysis in Sections 3.5.1.3 and 3.5.1.17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 2.2 (see direct/indirect effects discussion above).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for Sablefish. Large removals of Sablefish occurred, particularly in the JV and domestic fisheries. Catches that were under reported during the late 1980s may have contributed to abundance declines in the 1990s (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, bycatch and removals of Sablefish are predicted to continue in the IPHC longline fishery, State of Alaska groundfish fishery, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Due the highly migratory nature, Canadian fisheries, fishing within Canadian waters could be harvesting sablefish considered to be part of the GOA population. These removals are not accounted for in the TAC setting process and can be considered as having a potential adverse contribution to the cumulative case. Likewise, marine pollution is identified as having a reasonably foreseeable potential adverse contribution, but climate changes and regime shifts are not identified as being contributors to direct Sablefish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of sablefish and is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under FMP 2.2 (see Section 4.6.1.3).

- **Persistent Past Effects.** While past large removals of sablefish and other past effects on biomass have been identified (see Sections 3.5.1.3 and 3.5.1.17), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass, but climate changes and regime shifts are not identified as being contributors to Sablefish mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified and is considered insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Sablefish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion for this FMP).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the State of Alaska directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the IPHC longline and State of Alaska groundfish fisheries, Canadian fisheries and marine pollution, all have the potential to cause adverse effects.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration, and is considered insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability (see Direct/Indirect Effects).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Sablefish prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on sablefish prey species (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects of climate changes and regime shifts on Sablefish prey species could be beneficial or adverse. Marine pollution has been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-5 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** A cumulative effect is identified for prey availability, and the effect is considered insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the sablefish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish habitat suitability (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for sablefish include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Sections 3.5.1.3 and 3.5.1.17). Past fishing for Sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the Sablefish stock could be beneficial or adverse and marine pollution has been identified as a potential adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, they are determined to be is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is jeopardized.

4.6.1.4 Atka Mackerel

This section provides the effects analysis for BSAI and GOA Atka mackerel for each of the bookends under Alternative 2. The goal of Alternative 2 is to have a more aggressive harvesting policy while preventing overfishing of target groundfish stocks.

For further information regarding persistent past effects listed below in the text and in the tables, see the past/present effects analysis in Sections 3.5.1.4 and 3.5.1.18. Atka mackerel are managed as separate stocks in the BSAI and GOA; in the BSAI the species is managed under Tier 3a of the ABC and OFL definitions. However, in the GOA Atka mackerel are managed under Tier 6.

Direct/Indirect Effects of FMP 2.1

Model projections of future BSAI Atka mackerel catch and biomass levels under Alternative 2 assume the ABC level to equal the OFL.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Direct/indirect effects are summarized in Table 4.6-1.

<u>Catch and Fishing Mortality</u>

The average expected yield for BSAI Atka mackerel for the period 2003-2007 is 73,300 mt (Table H.4-17 of Appendix H). The catch and ABC values, which are equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.564 in 2003, and remain at that level through 2007. The fishing mortality rate under FMP 2.1 (0.564) is equivalent to the F_{MSY} proxy ($F_{35\%}$) which is the rate associated with the OFL. Overall, the projections show a 125 percent increase in the average fishing mortality rate from 2002 to 2007.

Under the specifications of the projection model, no new fisheries could be developed that were not present during the time period 1997-2001. The current GOA ABC and TAC level is 600 mt. This low level of TAC is intended to preclude a directed fishery and only provide for bycatch in other fisheries. This harvest strategy has been applied to GOA Atka mackerel since 1997. Under FMP 2.1, the ABC for GOA Atka mackerel would be set equal to the OFL of 6,200 mt. At this harvest level, it is likely that a fishery for GOA Atka mackerel would be developed; however, catches could not be projected within the model for FMP 2.1 (Table H.4-38 of Appendix H).

Total Biomass

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 2.1, model projections indicate that total BSAI Atka mackerel is expected to decline to a value of 388,000 mt by 2005, then increase to a value of 410,000 mt by 2007, with a 2003-2007 average value of 412,000 mt. Overall, the projections show about a 15 percent decrease in total biomass from 2002 to 2007 under FMP 2.1.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Therefore, model projections are unable to predict future biomass levels. However, as noted above, it is likely that a fishery for GOA Atka mackerel would be developed under FMP 2.1. The likely impact of this fishery, while not modeled explicitly, is that the stock of Atka mackerel in the GOA would remain stable or decrease.

Spawning Biomass

Female spawning biomass of BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H and Figure H.4-11 of Appendix H. Under FMP 2.1, model projections indicate that BSAI spawning biomass is expected to decline to a value of 65,300 mt by 2005, then increase to a value of 73,700 mt by 2007, with a 2003-2007 average value of 76,500 mt. Overall, the projections show about a 38 percent decrease in female spawning biomass from 2002 to 2007 under FMP 2.1. Projected spawning biomass exceeds the proxy BMSY value ($B_{35\%}$) of 77,800 mt in 2003, but dips below the B_{MSY} value for the years 2004-2007.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Therefore, model projections are unable to predict future biomass levels. However, as noted above, it is likely that a fishery for GOA Atka mackerel would be developed under FMP 2.1. The likely impact of this fishery, while not modeled explicitly, is that the stock of Atka mackerel in the GOA would remain stable or decrease.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1, the current network of spatial/temporal closed areas is repealed, except for the temporal/spatial closures designated in the Steller sea lion protection measures which will remain in place.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutians appear to be replenished by immigration and recruitment. In addition, the management measures which distribute TAC spatially and temporally, remain in place. That is, the overall BSAI TAC is allocated to three management areas (western, central, and Bering Sea/eastern Aleutians), and the regional TACs are further allocated to two seasons and there are limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. However, under FMP 2.1 catches of BSAI Atka mackerel would increase. It is unknown whether the increased effort would be accommodated through increased concentration of the catch or expanded exploitation in new areas, or a combination of both strategies. As such, the impacts of the spatial/temporal concentration of fishing mortality under FMP 2.1 is unknown.

Under FMP 2.1 there is the potential for development of a GOA Atka mackerel fishery and a substantial increase in fishing mortality. This could result in much higher concentrations of fishing mortality in time and space. However, it is unknown whether the potential increases in the spatial/temporal concentrations of GOA Atka mackerel catches under FMP 2.1 would affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success.

Status Determination

Model projections of future catches of BSAI Atka mackerel are equivalent to the OFL in all projection years under FMP 2.1(Table H.4-17 of Appendix H). Female spawning biomass is above $B_{35\%}$ (B_{MSY} proxy) in 2003, thus the BSAI Atka mackerel stock is determined to be above its MSST in the year 2003. Female spawning biomass dips below $B_{35\%}$ but remains above ½$B_{35\%}$ in each of the projection years 2004 to 2007. Long-term projections show that the stock does not rebuild to the $B_{35\%}$ level within 10 years of each of the projection years (2004 to 2007), therefore the BSAI Atka mackerel stock is determined to be below its MSST and overfished in the years 2004 to 2007.

GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Age and Size Composition

Under FMP 2.1, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.61 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

It is unknown what the actual level of GOA Atka mackerel catch would be under FMP 2.1. Although it is thought that changes in the age and size compositions of GOA Atka mackerel are more likely to be driven by variation in recruitment than to the effects of fishing, there is the potential for a substantial increase in fishing mortality under FMP 2.1 which could impact the age and size compositions in the short-term.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future are unknown.

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, Steller sea lion protection measures may provide habitat protection for Atka mackerel through effort limitations and reductions. However, under FMP 2.1 catches of BSAI Atka mackerel would increase. It is unknown whether the increased effort would be accommodated through increased concentration of the catch or expanded exploitation in new areas, or a combination of both strategies. It is unknown whether the level of habitat disturbance caused by the fishery under FMP 2.1 would be sufficient to affect the sustainability of the stock through a decrease in reproductive success. As such, the impacts to habitat suitability under FMP 2.1 are unknown.

Under FMP 2.1 there is the potential for development of a GOA Atka mackerel fishery and a substantial increase in fishing mortality. It is likely that the increased effort would be accommodated through increased concentration of the catch and expanded exploitation in new areas. It is unknown whether the level of habitat disturbance caused by the fishery under FMP 2.1 would be sufficient to affect the sustainability of the stock through a decrease in reproductive success. As such, the impacts to habitat suitability under FMP 2.1 are unknown.

Predation-Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions that are currently difficult to quantify. Higher catches of Atka mackerel could impact the amount of Atka mackerel available to the ecosystem. Under FMP 2.1, fewer commercial-sized Atka mackerel would be available as prey and predators in the ecosystem. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.1 will not impact prey availability for BSAI and GOA Atka mackerel. Overall however, information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1.

Summary of Effects of FMP 2.1 – Atka Mackerel

The criteria used to estimate the significance of impacts of the FMPs on the BSAI and GOA stock of Atka mackerel are outlined in Section 4.1.1.1. The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis as the model projections yielded results that were deemed either significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overfishing mortality rate (F_{OFL}) and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 2.1. Because the mean projected BSAI Atka mackerel fishing mortality rates are equal to the overfishing mortality rate for the projection years 2003-2007, the overfishing aspect of the fishing mortality effect is insignificant for Alternative 2.1. The spawning stock biomass of BSAI Atka mackerel in 2003 is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is determined to be above its MSST for the year 2003 under FMP 2.1. However, the BSAI Atka mackerel stock is determined to be below its MSST and overfished in the years 2004 to 2007. Thus, the impact of the change in biomass aspect of the fishing mortality effect is determined to be significantly adverse. Although the BSAI Atka mackerel stock is determined to be below its MSST in the years 2004 to 2007, it is unknown whether the potential increases in the spatial/temporal concentrations of BSAI Atka mackerel catches under FMP 2.1 would affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success. Therefore the impact of the spatial temporal concentration of the catch is unknown. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.1 will not impact prey availability for BSAI Atka mackerel and the impact to the prey availability effect is determined to be insignificant. Because it is unknown whether the level of habitat disturbance caused by the fishery under FMP 2.1 would be sufficient to affect the sustainability of the BSAI Atka mackerel stock through a decrease in reproductive success, the impact to habitat suitability under FMP 2.1 is determined to be unknown.

Relative to the comparative baseline, under FMP 2.1, the BSAI Atka mackerel stock is overfished. Spawning biomass declines through 2005, after which biomass increases. Long-term (10 and 20 year) projections of spawning biomass show a very stable trend in biomass after 2007, with levels just below the $B_{35\%}$ level of 77,800 mt.

The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under FMP 2.1. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration and habitat suitability effects is also unknown under FMP 2.1. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.1 will not impact prey availability for GOA Atka mackerel, and the impact to prey availability is determined to be insignificant.

Relative to the comparative baseline, under FMP 2.1, the GOA Atka mackerel stock is likely to remain at low and possibly decreased abundance. There is the potential for a directed fishery to develop for GOA Atka mackerel.

Cumulative Effects of FMP 2.1 – BSAI Atka Mackerel

External effects and the resultant cumulative effects associated with FMP 2.1 for BSAI Atka mackerel are depicted on Table 4.5-6.

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 2.1 (see Section 4.6.1.4).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the BSAI Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the BSAI Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of BSAI Atka mackerel and the effect is judged to be insignificant. Fishing effort would not exceed the OFL and the stock is above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be significantly adverse under FMP 2.1 (see Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified under FMP 2.1. The effect is judged to be significantly adverse. Due to the internal effects of the FMP, biomass of the BSAI stock is projected to fall below the MSST from 2004 to 2007. The additional mortality from external human controlled events will likely cause additional reduction in biomass.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** It is unknown whether the potential increases in the spatial/temporal concentrations of BSAI Atka mackerel catches under FMP 2.1 would affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success (see Direct/Indirect Effects).

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. Past commercial whaling and sealing also removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown since it is not known how the changes in spatial/temporal concentration of the fishery under the FMP would affect the sustainability of the stock.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is judged insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability and the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Atka mackerel stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** It is unknown whether the level of habitat disturbance caused by the fishery under FMP 2.1 would be sufficient to affect the sustainability of the stock (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for BSAI Atka mackerel stocks include past foreign, JV, domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its significance on the BSAI Atka mackerel stock is unknown.

Direct/Indirect Effects of FMP 2.2

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 2.2 assume the maximum permissible fishing mortality rate according to Amendment 56 ABC/OFL definitions.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA; therefore model projections of future biomass levels were not produced. Direct/indirect effects are summarized in Table 4.6-1.

Catch and Fishing Mortality

The average expected yield for BSAI Atka mackerel for the period 2003-2007 is 63,400 mt. The catch and ABC values, which are equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.447 in 2003, decrease to 0.387 by 2005, then increase to 0.406 in 2007. Overall, the projections show a 62 percent increase in the average fishing mortality rate from 2002 to 2007. These values are well below the F_{MSY} proxy value of 0.564 which is the rate associated with the OFL (Table H.4-17 of Appendix H).

Projections of GOA Atka mackerel under FMP 2.2 indicate that catches will likely average 300 mt through 2007 (Table H.4-38 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g. Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

Total Biomass

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 2.2, model projections indicate that total BSAI Atka mackerel is expected to decline to a value of 412,000 mt by 2005, then increase to a value of 442,000 mt by 2007, with a 2003-2007 average value of 432,000 mt. Overall, the projections show an 8 percent decrease in total biomass from 2002 to 2007 under FMP 2.2.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Therefore, model projections are unable to predict future biomass levels.

Spawning Biomass

Female spawning biomass of BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H. Under FMP 2.2, model projections indicate that BSAI spawning biomass is expected to decline to a value of 77,700 mt by 2005, then increase to a value of 87,600 mt by 2007, with a 2003-2007 average value of 87,600 mt. Overall, the projections show a 26 percent decrease in female spawning biomass from 2002 to 2007 under FMP 2.2. Projected spawning biomass dips slightly below the proxy BMSY value of 77,800 mt in 2005, but otherwise exceeds the B_{MSY} value for the projection years 2003-2007.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Therefore, model projections are unable to predict future biomass levels.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.2, the current network of spatial/temporal closed areas is in place. The closures designated in the Steller sea lion protection measures probably have the largest impact relative to Atka mackerel.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutians appear to be replenished by immigration and recruitment. In addition, management measures would be in place that have the effect of spreading out the harvest in time and space. The overall BSAI TAC would be allocated to three management areas (western, central, and Bering Sea/eastern Aleutians). The regional TACs would be further allocated to two seasons and there would be limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. The temporal/spatial concentration of the catch under FMP 2.2 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST.

Status Determination

Model projections of future catches of BSAI Atka mackerel are below the OFL in all years under FMP 2.2 (Table H.4-17 of Appendix H). Female spawning biomass is above $B_{35\%}$ (B_{MSY} proxy) in 2003-2004 and 2006-2007. Female spawning biomass dips slightly below $B_{35\%}$ in 2005, but rebuilds to the $B_{35\%}$ level by the following year, therefore the BSAI Atka mackerel stock is determined to be above its MSST and is not overfished under FMP 2.2.

GOA Atka mackerel are in Tier 6 and the stock's MSST is unknown; therefore a status determination cannot be made.

Age and Size Composition

Under FMP 2.2, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.73 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level, therefore, it is unlikely that the age and size compositions would change in the future under FMP 2.2. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than to the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future are unknown.

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, Steller sea lion protection measures may provide habitat protection for Atka mackerel through effort limitations and reductions. The level of habitat disturbance caused by the fishery under FMP 2.2, is not likely to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST.

Predator/Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.2. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.2 will not impact prey availability for BSAI and GOA Atka mackerel.

Summary of Effects of FMP 2.2 – Atka Mackerel

The criteria used to estimate the significance of impacts of the FMPs on the BSAI and GOA stock of Atka mackerel are outlined in Section 4.1.1.1. The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis as the model projections yielded results that were deemed either significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overfishing mortality rate (F_{OFL}) and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 2.2. Because the mean projected BSAI Atka mackerel fishing mortality rates are below the overfishing mortality rate, and the spawning stock is above its MSST in each of the projection years (2003-2007), the fishing mortality effect is insignificant for FMP 2.2. As noted above, the BSAI Atka mackerel stock is determined to be above its MSST under FMP 2.2. Thus, for all other effects, it was determined that FMP 2.2 did not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST, therefore the effects were insignificant.

Relative to the comparative baseline, under FMP 2.2, the BSAI Atka mackerel stock is not overfished. Spawning biomass declines through 2005, after which biomass increases. Long-term projections (10 and 20 year projections) of spawning biomass show a very stable trend in biomass after 2007, with levels similar to the 2007 level of 87,600 mt.

The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under FMP 2.2. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration and habitat suitability effects are also unknown under FMP 2.2. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.2 will not impact prey availability for BSAI Atka mackerel and the impact to the prey availability effect is determined to be insignificant.

Relative to the comparative baseline, under FMP 2.2, the GOA Atka mackerel stock is likely to remain at a low abundance under continued low exploitation as a bycatch fishery only.

Cumulative Effects of FMP 2.2

External effects and the resultant cumulative effects associated with FMP 2.2 are shown in Tables 4.5-6.

BSAI Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 2.2 (see Section 4.6.1.4). Overall, the projections show a 62 percent increase in the average fishing mortality rate from 2002 to 2007. These values are well below the F_{MSY} proxy value of 0.564 which is the rate associated with the OFL.

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the BSAI Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the BSAI Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of BSAI Atka mackerel, and the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be insignificant under FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 in the BSAI, marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass, and climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The temporal/spatial concentration of the catch under the FMP does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST and the impact is judged insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** As discussed for FMP 2.1, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, since past fisheries could have had a beneficial effect on Atka mackerel recruitment by reducing the adult Atka mackerel biomass, lingering beneficial effects are identified for change in reproductive success. In addition, past commercial whaling and sealing also removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, marine pollution could contribute adversely to genetic changes and reduced recruitment, and climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration, and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is judged insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. Marine pollution has been identified as a reasonably foreseeable future adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for prey availability, and the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Atka mackerel stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The level of habitat disturbance caused by the fishery under FMP 2.2, does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST, and the effect is judged insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for BSAI Atka mackerel stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4) Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As discussed under FMP 2.1, impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has been identified as a potential adverse contributing factor.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Atka mackerel stock to sustain itself at or above MSST is jeopardized.

Cumulative Effects of FMP 2.1 and FMP 2.2 – GOA Atka Mackerel

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Therefore, the internal effects of the FMPs are unknown for all categories with the exception of prey availability. In addition, the external effects and cumulative effects are the same for each FMP. Cumulative effects are summarized in Table 4.5-7.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under FMP 2.1 and FMP 2.2. The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under both FMP.

- **Persistent Past Effects.** Past effects of the past foreign, JV, and domestic, fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, and JV fisheries, and have had a lingering effect on the GOA Atka mackerel population, which has not yet recovered (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the population is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 and FMP 2.2 is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and the stock's MSST is unknown; therefore a status determination cannot be made.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Atka mackerel stock is unknown under FMP 2.1 and FMP 2.2. Current reliable estimates of total and spawning biomass are unknown for GOA Atka mackerel.

- **Persistent Past Effects.** Persistent effects of the past foreign, JV, and domestic fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, and JV fisheries, and have had a lingering effect on the GOA Atka mackerel population, which has not yet recovered (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the population is affected. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified under FMP 2.1 and FMP 2.2, however, the significance of the effect is unknown.

Spatial/Temporal Concentration of Catch
  - Change in Genetic Structure of Population
  - Change in Reproductive Success

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel, which are in Tier 6, the significance of the spatial temporal concentration effects is also unknown under both FMP.

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. The past highly localized fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Also, climate changes and regime shifts could impact spawning success since a shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.1 and FMP 2.2 will not impact prey availability for BSAI Atka mackerel. The impact to prey availability is determined to be insignificant.

- **Persistent Past Effects.** While lingering population level effects on the invertebrate prey of Atka mackerel from past foreign, state, and domestic fisheries, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Atka mackerel prey species could be either beneficial or adverse depending on the direction of change. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is unknown since the direction of external effects is unknown.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the habitat suitability effects is also unknown under FMP 2.1.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA Atka mackerel stocks include past foreign, JV, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.18). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from climate changes and regime shifts on the GOA Atka mackerel could be either favorable or unfavorable depending on the direction of change. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, its significance on the GOA Atka mackerel stock is unknown.

4.6.1.5 Yellowfin Sole and Shallow Water Flatfish

Numerous fishery management actions have been implemented that affect the yellowfin sole fisheries in the BSAI. These actions are described in more detail in Section 3.5.1.5 of this SEIS. Yellowfin sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species by the National Standard Guidelines.

Eight flatfish species inhabit shallow waters and are managed in the shallow water flatfish assemblage in the GOA. They include: northern and southern rock sole, yellowfin sole, starry flounder, butter sole, English sole, Alaska plaice and sand sole. Survey results from 2001 indicate that over half of the estimated biomass (54 percent) of this assemblage are northern and southern rock sole. The shallow water group is managed as a Tier 4 and Tier 5 species in the GOA (Turnock *et al.* 2001).

For further information regarding persistent past effects listed below in the text and in these tables (see Sections 3.5.1.5 and 3.5.1.19).

BSAI Yellowfin Sole – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Direct/indirect effects are summarized in Table 4.6-1.

Total Biomass

The total biomass of yellowfin sole at the start of 2002 is estimated to be 1,552,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 2.1, model projections indicate that the total BSAI biomass is expected to decline more than 12 percent of the 2002 value to 1,361,000 mt by 2007, with a 2003-2007 average value of 1,435,000 mt. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to decline about 8 percent of the 2002 value to 1,420,000 mt by 2007, with a 2003-2007 average value of 1,467,000 mt.

Spawning Biomass

Spawning biomass of female yellowfin sole at the start of 2002 is estimated to be 450,700 mt. Model projections of future yellowfin sole spawning biomass estimates are shown in Table H.4-4 of Appendix H and Figure H.4-3 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to decline more than 25 percent of the 2002 value to 337,100 mt by 2007, with a 2003-2007 average value of 386,700 mt. Projected female spawning biomass is estimated to remain above the BMSY proxy value of 336,900 mt by the end of the five year projection.

Under FMP 2.2, model projections indicate that female spawning biomass is expected to decline 19 percent of the 2002 value to 364,900 mt by 2007, with a 2003-2007 average value of 402,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Under FMP 2.1, model projections show this value will increase each year starting in 2004 ending at 0.138 in 2007. Under this FMP fishing mortality is at, but does not exceed, the F_{MSY} proxy value in 2007 (Table H.4-4 of Appendix H).

Under FMP 2.2, model projections show that this value will be 0.115 for 2003-2005 and decrease to 0.109 by 2007. This maximum value under this FMP is less than the F_{MSY} proxy value of 0.138, the rate associated with the OFL (Table H.4-4 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI yellowfin sole harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, Red King crab savings area, etc.), or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that yellowfin sole fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would not be affected under FMP 2.2.

Status Determination

Model projections of future catches of BSAI yellowfin sole are at (but do not exceed) the OFLs in 2003-2007 under FMP 2.1 and FMP 2.2. Female spawning biomass is above the MSST level in 2003-2007, as it was in the 2002 baseline year.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 5.9 years. Under FMP 2.2, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.1 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.0 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of yellowfin sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on yellowfin sole would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Yellowfin Sole

Table 4.6-1 summarizes the effects of FMP 2.1 and FMP 2.2 on BSAI yellowfin sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis as the model projections yielded results that were determined either significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize FOFL and the MSST as a basis for beneficial or adverse impacts on fishing mortality and changes in reproductive success for each FMP. A thorough description of the rationale for the MSST can be found in the National Standard Guidelines 50 CFR Part 600 (FR Vol. 63, No. 84, 24212-24237). Under FMP 2.1 and FMP 2.2, the spawning stock biomass of BSAI yellowfin sole is expected to be above the MSST throughout the five year projection. Since the fishing mortality rate does not exceed FOFL and the stock is projected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant.

Relative to the 2002 comparative baseline, the yellowfin sole stock is projected to continue to not be overfished under these FMPs. The 20 year projection indicates that the female spawning stock is expected to decline until 2010 to below B_{MSY} levels and will increase thereafter through the end of the projection to about the B_{MSY} level in 2023.

Cumulative Effects of FMP 2.1 and FMP 2.2

External effects and the resultant cumulative effects associated with FMP 2.1 and FMP 2.2 are shown in Table 4.5-8.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI yellowfin sole is rated as insignificant under FMP 2.1 and FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of yellowfin sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI yellowfin sole, but is rated as insignificant. Fishing mortality at projected levels is at, but do not exceed the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** It is not expected that FMP 2.1 or FMP 2.2 will result in an significant effect on yellowfin sole (see Section 4.6.1.5).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the yellowfin sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Section 3.5.1.5 and 3.10).

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI yellowfin sole and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the spawning biomass is above the BMSY value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI yellowfin sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of yellowfin sole due to climate changes and regime shifts are potentially beneficial or adverse as described above for change in biomass. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI yellowfin sole.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the yellowfin sole catch and this effect is ranked as insignificant. The spatial/temporal distribution of yellowfin sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI yellowfin sole is ranked as insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI yellowfin sole stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Section 3.5.1.5 and 3.10).

- **Reasonably Foreseeable Future External Effects.** As described for change in biomass, effects of climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. Marine pollution has been identified as having a potential adverse contribution since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for change in prey availability; however, these effects are considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI yellowfin sole is ranked as insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are identified for BSAI yellowfin sole include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Section 3.5.1.5 and Section 3.6.

- **Reasonably Foreseeable Future External Effects.** As described for change in biomass, climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for BSAI yellowfin sole habitat suitability and these effects are considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the yellowfin sole stock to sustain itself at or above the MSST is jeopardized.

GOA Shallow Water Flatfish – Direct/Indirect Effects of FMP 2.1and FMP 2.2

Direct/indirect effects are summarized in Table 4.6-1.

Total Biomass and Spawning Biomass

Estimates of total and spawning biomass are not available for the GOA shallow water flatfish species.

Fishing Mortality

The catch of GOA shallow water flatfish in 2002 was estimated to be 6,800 mt. Model projections of future catch are shown in Table H.4-27 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to decrease from the 2002 value to 1,200 mt in 2003 and then increase gradually to 1,400 mt in 2006 and 2007. The 2003-2007 average catch is 1,300 mt (20 percent of the 2002 catch). Under FMP 2.2, model projections indicate that the catch is expected to decrease from 6,000 mt in 2003 to 5,000 mt in 2007. The 2003-2007 average catch is 5,600 mt.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual GOA shallow water flatfish harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates.

Because FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA shallow water flatfish fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual GOA shallow water flatfish harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information for flatfish species in the shallow water complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition projections are not available for the GOA shallow water flatfish species.

Sex Ratio

The sex ratio of shallow water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on shallow water flatfish would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Shallow Water Flatfish

The direct and indirect effects of FMP 2.1 and FMP 2.2 on GOA shallow water flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five year projection and what level of fishing mortality corresponds to the modeled catch estimated under this FMP (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

External effects and the resultant cumulative effects associated with FMP 1 are shown in Table 4.5-9.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under FMP 2.1 and FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past JV and domestic fisheries have been identified as having lingering past adverse effects on the GOA shallow water flatfish complex (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shallow water flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since shallow water flatfish species bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA shallow water flatfish, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** Since the total and spawning biomass estimates for GOA shallow water species is unavailable, the effects of FMP 2.1 and FMP 2.2 on change in biomass is unknown.

- **Persistent Past Effects.** The past JV and domestic fisheries are identified as having past lingering adverse effects on the biomass levels of GOA shallow water flatfish (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Events.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the shallow water flatfish species biomass level. For more information on climate changes and regime shifts (see Sections 3.5.1.19 and 3.10). The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for change in biomass of GOA shallow water flatfish, but is rated as unknown. Fishing mortality at projected levels is well below the OFL for this stock. It is unknown if the combined effects of internal removals and removals are likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of the annual GOA shallow water flatfish harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates. Because FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA shallow water flatfish fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. However, little is known about the spatial/temporal characteristics of GOA shallow water flatfish, therefore the effects of FMP 2.1 and FMP 2.2 are rated as unknown.

- **Persistent Past Effects.** Past effects have not been identified for the change in genetic structure or the change in reproductive success of GOA shallow water flatfish.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shallow water flatfish species due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution, and th State of Alaska scallop fishery has been identified as a non-contributing factor to the change in genetic structure and reproductive success since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** Cumulative effects are possible for the change in genetic structure and reproductive success of GOA shallow water flatfish, but are rated as unknown. It is unknown if the combined effects of internal removals and removals due to reasonably foreseeable future external events are likely to jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA shallow water flatfish is determined to be unknown (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA shallow water flatfish stock complex and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.1.19 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of shallow water flatfish prey species is not expected to occur in this fishery.

- **Cumulative Effects.** Cumulative effects for change in prey availability are unknown. The predation-mediated impacts of FMP 2.1 and FMP 2.2 on shallow water flatfish are governed by a complex web of indirect interactions that are currently difficult to quantify.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be unknown (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for GOA shallow water flatfish include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Section 3.5.1.19 and Section 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution. The State of Alaska scallop fishery is also identified as a potential adverse contributor to GOA shallow water flatfish habitat suitability (see Section 3.6).

- **Cumulative Effects.** Cumulative effects are identified for GOA shallow water flatfish habitat suitability; however, these effects are unknown. It is unknown if the combination of internal and external habitat disturbances will to lead to a detectable change in spawning or rearing success such that the ability of the GOA shallow water flatfish stock to maintain current population levels is jeopardized.

4.6.1.6 Rock Sole

BSAI rock sole is described in more detail in Section 3.5.1.6 of this Programmatic SEIS. Rock sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Direct/indirect effects are summarized in Table 4.6-1.

Total Biomass

The total biomass of rock sole at the start of 2002 is estimated to be 970,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 2.1, model projections indicate that the total BSAI biomass is expected to decline 30 percent of the 2002 value to 680,000 mt by 2007, with a 2003-2007 average value of 764,000 mt. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to decline about 33 percent of the 2002 value to 645,000 mt by 2007, with a 2003-2007 average value of 744,000 mt.

Spawning Biomass

Spawning biomass of female rock sole at the start of 2002 is estimated to be 331,000 mt. Model projections of future rock sole spawning biomass estimates are shown in Table H.4-7 and Figure H.4-6 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to decline 47 percent of the 2002 value to 176,400 mt by 2007, with a 2003-2007 average value of 237,500 mt. Projected female spawning biomass is estimated to remain above the B_{MSY} proxy value of 136,700 mt throughout the five year projection.

Under FMP 2.2, model projections indicate that female spawning biomass is expected to decline 51 percent of the 2002 value to 161,300 mt by 2007, with a 2003-2007 average value of 229,000 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.055. Under FMP 2.1, model projections show this value will increase each year reaching 0.126 in 2007. Under FMP 2.2, model projections show this value will steadily increase to 0.161 by 2007. These maximum values are less than the F_{MSY} proxy value of 0.21, the rate associated with the OFL (Table H.4-7 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI rock sole harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.) or areas where they avoided because of high bycatch.

The spatial/temporal characteristics of the annual BSAI rock sole harvest could be affected under FMP 2.2 if managers adopt PSC limits proportional to the abundance levels of the bycatch species. However, it is not known how this would affect future fishing behavior in terms of avoidance of bycatch species.

Status Determination

Model projections of future catches indicate that the fishing mortality rate does not exceed the OFL and that female spawning stock size of BSAI rock sole are above the MSST levels in 2003-2007 under FMP 2.1 and FMP 2.2. The rock sole stock is also above the MSST level in 2002 baseline year.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections is 4.4 years. Under FMP 2.2, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.6 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of rock sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on rock sole would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Rock Sole

Under FMP 2.1 and FMP 2.2, the spawning stock biomass of BSAI rock sole is expected to be above the MSST through 2007. Since the F_{OFL} is not exceed and the female spawning stock is currently above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the rock sole stock is projected to continue to not be overfished under these FMPs. The 20 year projection (Figure H.4-6 of Appendix H) indicates that the female spawning stock is expected to decline until 2010 to B_{MSY} levels and will increase thereafter through the end of the projection in 2023 under FMP 2.1. Under FMP 2.2, the 20 year projection indicates that the female spawning stock is expected to decline until 2010. Beginning in 2009 it will be below the B_{MSY} level for three years before increasing to the end of the projection in 2003, exceeding the B_{ABC} level in 2015.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects are summarized in Table 4.5-10 for BSAI rock sole.

Mortality

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rock sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI rock sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effects of the fisheries on BSAI rock sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the rock sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.6 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI rock sole, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

 – Change in Genetic Structure of Population
 – Change in Reproductive Success

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the BSAI rock sole. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of BSAI rock sole. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of rock sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI rock sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rock sole catch, and is ranked as insignificant. The spatial/temporal distribution of rock sole catch is not expected to change significantly. The combined effect of internal removals and removals due to Reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in prey availability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some forage species (i.e. capelin); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in habitat suitability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI rock sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI rock sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the rock sole stock to sustain itself at or above the MSST is jeopardized.

4.6.1.7 Flathead Sole

BSAI and GOA flathead sole are described in more detail in Sections 3.5.1.7 and 3.5.1.20 of this Programmatic SEIS. Flathead sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2002, flathead sole were managed independent of the other flatfish complex in the GOA. Until recently, flathead sole were managed under Tier 3; as of 2004 GOA flathead sole are managed under Tier 3. GOA flathead sole were modeled under the Tier 4 category for this analysis.

BSAI Flathead Sole – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

Total biomass of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 2.1, model projections indicate that BSAI biomass is expected to decrease to a value of 454,000 mt in 2007, with a 2003 to 2007 average value of 475,000 mt. Under FMP 2.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 477,000 mt in 2008, with a 2003-2008 average value of 485,000 mt.

Spawning Biomass

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 229,400 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 and Figure H.4-7 of Appendix H. Under FMP 2.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 146,300 mt in 2007. The projected average biomass from 2003-2007 is 185,600 mt. Under FMP 2.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 149,200 mt in 2008, with a 2003-2008 average value of 187,100 mt.

Fishing Mortality

Under FMP 2.1, the projected fishing mortality imposed on the BSAI flathead sole stock is 0.11 in 2003, and increases to 0.145 in 2007. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 63 percent in 2003 and decreases to 57 percent in 2007, with an average of 60 percent from 2003-2007 (Table H.4-8 of Appendix H).

Under FMP 2.2, the projected fishing mortality imposed on the BSAI flathead sole stock is approximately 0.099 in 2003, increasing to 0.156 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 66 percent in 2003, increasing to 76 percent in 2005, and decreases to 57 percent in 2008, with an average of 67 percent from 2003-2008 (Table H.4-8 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 involves the resumption of fishing in a number of areas currently closed, and these areas are largely in the EBS. The projected average harvest from 2003-2008 increased to 35,300 mt, due largely to increased catch in the directed flathead sole fishery (13,960 mt, 40 percent) and the Pacific cod trawl fishery (14,320 mt, 41 percent).

Under FMP 2.2, the average projected catch from 2003-2008 is 19,200 mt, of which 6,700 mt (34 percent) occurred in the EBS shelf flathead sole fishery with the remaining harvest divided approximately evenly between the yellowfin sole, rock sole, Pacific cod, and walleye pollock fisheries.

Status Determination

Under FMP 2.1 and FMP 2.2, the ABC is set equal to the OFL, removing the buffer between these two harvest regulations. Model projections of future catches of BSAI flathead sole are below the OFL level from 2003 to 2008.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections, is 4.02 years. Under FMP 2.2, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-8 of Appendix H), is 4.38 years. This compares with a mean age in the equilibrium unfished stock of 5.39 years.

Sex Ratio

The sex ratio of BSAI flathead sole is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 and FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 2.1 and FMP 2.2.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Flathead Sole

Although the ABC and OFL levels for flathead sole are equivalent under FMP 2.1, the F_{OFL} is not reduced for lower stock sizes, and the harvest of flathead sole under FMP 2.1 is increased relative to recent levels, the fishing rates on flathead sole do not exceed the $F_{40\%}$ reference point and are within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Thus, the direct and indirect effects of FMP 2.1 on flathead sole are considered insignificant.

Because the BSAI flathead sole are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 2.2 are considered insignificant. Fishing rates are lower than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Relative to the 2002 comparative baseline, the flathead sole stock is projected to continue to not be overfished under this FMP. Under FMP 2.1, the twenty year projection (Figure H.4-7 of Appendix H) indicates that the female spawning stock expected to decrease until 2010 at which time it will be begin to steadily increase throughout the end of the projection. Under FMP 2.2, the twenty year projection indicates that the female spawning stock expected to decrease until 2009 at which time it will be begin to steadily increase throughout the end of the projection. The female spawning stock is estimated to remain above B_{ABC} throughout the projection for both FMPs.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects of BSAI flathead sole are summarized in Table 4.5-11.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI flathead sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.7 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI flathead sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the spawning biomass is above the B_{MSY} value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI flathead sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch, and is ranked as insignificant. The spatial/temporal distribution of flathead sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects are not identified for the change in prey availability of the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.7.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI flathead sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at or above the MSST is jeopardized.

GOA Flathead Sole – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass

Estimates of total and spawning biomass are currently unavailable for this species.

Fishing Mortality

The catch of GOA flathead sole in 2002 was estimated to be 2,000 mt. Model projections of future catch are shown in Table H.4-28 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to decrease to 1,600 mt in 2003 and slowly increase to 2,400 in 2006 and 2007. The 2003-2007 average catch is estimated at 2,100 mt.

Under FMP 2.2, model projections indicate that the catch is expected to decrease to 1,600 mt in the first two years of the projections and then be at 1,500 mt in the last two years. The 2003-2007 average catch is 1,600 mt (80 percent of the 2002 catch). The average annual fishing mortality imposed on the flathead sole stock in 2002 is 0.055. Model projections show this value will increase to 0.137 in 2007. These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the GOA flathead sole harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA flathead sole fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual GOA flathead sole harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information GOA flathead sole requires that they are classified into the Tier 4 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are currently unavailable for this species.

Sex Ratio

The sex ratio of flathead sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on flathead sole would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – GOA Flathead Sole

The direct and indirect effects of FMP 2.1 and FMP 2.2 on GOA flathead sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five year projection and what level of fishing mortality corresponds to the modeled catch estimated under this FMP (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects of GOA flathead sole are summarized in Table 4.5-12.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Removals by these fisheries have had a lingering adverse effect on GOA flathead sole (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since GOA flathead sole bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonable foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in biomass level is rated as unknown since MSST is unable to be determined at this time.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Large removals of flathead sole by these fisheries is determined to have had a lingering effect on the GOA flathead sole stock (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. For more information on climate changes and regime shifts see Sections 3.5.1.20 and 3.10. The State of Alaska scallop fishery is identified as a non-contributing factor for change in biomass level since flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA flathead sole, but is unknown. The MSST is not able to be determined and the total and spawning biomass estimates are currently unavailable. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA flathead sole stock. However, climate changes and regime shifts have been identified as having a beneficial or adverse effect on GOA flathead sole reproductive success see Section 3.5.1.20 for more information on the effects of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA flathead sole. The State of Alaska scallop fishery has been identified as a non-contributing factor to change in genetic structure and change in reproductive success since GOA flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch; however, this effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA flathead sole stock and include climate changes and regime shifts. For more information on the effects of climate changes and regime shifts on the GOA flathead sole stock see Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole prey availability. The State of Alaska scallop fishery gear could impact flathead sole benthic prey availability and/or quality.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to sustain itself at current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects identified for GOA flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole habitat suitability. For information on the effects of fishery gear on EFH see Section 3.6.

- **Cumulative Effects.** A cumulative effect is identified for GOA flathead sole habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at current population levels.

4.6.1.8 Arrowtooth Flounder

BSAI and GOA arrowtooth flounder are described in more detail in Sections 3.5.1.8 and 3.5.1.21 of this Programmatic SEIS. Arrowtooth flounder is managed as its own stock under the BSAI and GOA groundfish FMPs under the Tier 3 management category, thus MSSTs are defined for these species.

BSAI Arrowtooth Flounder – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

The total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 2.1, model projections indicate that the total BSAI biomass is expected to decline 28 percent of the 2002 value to 588,000 mt by 2007, with a 2003-2007 average value of 669,000 mt. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to decline about 27 percent of the 2002 value to 594,000 mt by 2007, with a 2003-2007 average value of 673,000 mt.

Spawning Biomass

Spawning biomass of female BSAI arrowtooth flounder at the start of 2002 is estimated to be 475,900 mt. Model projections of future arrowtooth flounder spawning biomass estimates are shown in Table H.4-6 and Figure H.4-5 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to decline 32 percent of the 2002 value to 323,500 mt by 2007, with a 2003-2007 average value of 384,000 mt. Projected female spawning biomass is estimated to remain above the B_{MSY} proxy value of 182,900 mt throughout the five year projection.

Under FMP 2.2, model projections indicate that female spawning biomass is expected to decline 31 percent of the 2002 value to 327,600 mt by 2007, with a 2003-2007 average value of 386,700 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 182,900 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015. Under FMP 2.1, model projections under this FMP show this value will increase to double the 2002 baseline value in 2007. Under FMP 2.2, model projections show this value will steadily increase to 0.032 by 2007. These projected values are below the F_{MSY} proxy value (0.38), the rate associated with the OFL (Table H.4-6 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.) or areas which were previously avoided because of high bycatch.

Because FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that arrowtooth flounder fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

Model projections of future catches of BSAI arrowtooth flounder are below the OFL in 2004-2007 under FMP 2.1 and FMP 2.2. The BSAI arrowtooth flounder female spawning biomass is above the MSST level throughout the five year projection and in the 2002 baseline year.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections, is 4.5 years. Under FMP 2.2, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-6 of Appendix H), is 4.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.4 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the BSAI have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 2.1 and FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on BSAI arrowtooth flounder would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Arrowtooth Flounder

Under FMP 2.1 and FMP 2.2, the spawning stock biomass of BSAI arrowtooth flounder is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the BSAI spawning biomass is projected to continue to not be overfished under these FMPs. The 20 year projection (Figure H.4-5 of Appendix H) indicates that both female spawning stocks are expected to remain above B_{ABC} levels through the end of the projection in 2023.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI arrowtooth flounder are summarized in Table 4.5-13.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI arrowtooth flounder is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of arrowtooth flounder. The IPHC longline fishery is identified as a potential adverse contributor to BSAI arrowtooth flounder mortality since arrowtooth flounder are caught as bycatch in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor to BSAI arrowtooth flounder mortality since bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on arrowtooth flounder biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the arrowtooth flounder biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Section 3.5.1.8 and 3.10. The IPHC longline fishery has been identified as a potential adverse contributor to BSAI arrowtooth flounder biomass level since bycatch is expected to occur in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor since arrowtooth flounder bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI arrowtooth flounder. Climate changes and regime shifts are identified as having had potential adverse or beneficial effects on the reproductive success of BSAI arrowtooth flounder see Section 3.5.1.8 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of arrowtooth flounder due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI arrowtooth flounder. The IPHC longline fishery is identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since the removals are not expected to be significant. The State of Alaska herring fishery is also identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch, and is ranked as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified include the past foreign, JV, and domestic fisheries, State of Alaska groundfish fisheries, State of Alaska herring fisheries and climate changes and regime shifts (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potential beneficial or adverse. Some forage species (i.e. capelin and herring), shrimp and pollock respond to variations in water temperatures which vary with the climate. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor to prey availability since the bycatch of prey species is not expected in this fishery. The State of Alaska herring fishery is identified as a potential adverse contributor to prey availability by reducing the availability of herring.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI arrowtooth flounder include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.8.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery and the State of Alaska herring fishery are both identified as non-contributing factors to BSAI arrowtooth flounder habitat suitability. The impacts from the fishery gear is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for BSAI arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

GOA Arrowtooth Flounder – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

The total biomass of GOA arrowtooth flounder at the start of 2002 is estimated to be 1,816,000 mt. Model projections of future total GOA biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 2.1, model projections indicate that the total GOA biomass is expected to increase 15 percent of the 2002 value to 2,086,000 mt by 2007, with a 2003-2007 average value of 1,982,000 mt. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to increase about 14 percent of the 2002 value to 2,080,000 mt by 2007, with a 2003-2007 average value of 1,979,000 mt.

Spawning Biomass

Spawning biomass of female GOA arrowtooth flounder at the start of 2002 is estimated to be 1,113,800 mt. Model projections of future arrowtooth flounder spawning biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to increase 2 percent of the 2002 value to 1,125,800 mt by 2007, with a 2003-2007 average value of 1,127,200 mt. Projected female spawning biomass is estimated to remain above the B_{MSY} proxy value of 432,700 mt throughout the five year projection.

Under FMP 2.2, model projections indicate that female spawning biomass is expected to increase 3 percent of the 2002 value to 1,151,300 mt by 2007, with a 2003-2007 average value of 1,140,200 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017. Under FMP 2.1, model projections indicate that fishing mortality will remain at about this level at 0.017 or 0.018 each year through 2007. Under FMP 2.2, model projections show this value will steadily decrease to 0.01 by 2007. These projected values are below the F_{MSY} proxy value (0.165), the rate associated with the OFL (Table H.4-29 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.) or areas which were previously avoided because of high bycatch.

Because FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that arrowtooth flounder fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

Model projections of future catches of GOA arrowtooth flounder are below the OFLs in 2004-2007 under FMP 2.1 and FMP 2.2. The GOA arrowtooth flounder female spawning biomass is above the MSST level throughout the five year projection and in the 2002 baseline year.

Age and Size Composition

Under FMP 2.1, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-29 of Appendix H), is 5.0 years. Under FMP 2.2, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-29 of Appendix H), is 5.0 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.1 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the GOA have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1and FMP 2.2 on GOA arrowtooth flounder would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1.

Summary of Effects of FMP 2.1 and FMP 2.2 – GOA Arrowtooth Flounder

Under FMP 2.1 and FMP 2.2, the spawning stock biomass of GOA arrowtooth flounder is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under this FMP are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the GOA spawning biomass is projected to continue to not be overfished under these FMPs. The 20 year projection (Table H.4-29 of Appendix H) indicates that both female spawning stocks are expected to remain above B_{ABC} levels through the end of the projection in 2023.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA arrowtooth flounder are summarized in Table 4.5-14.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA arrowtooth flounder is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on GOA arrowtooth flounder biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects identified for the change in genetic structure and reproductive success of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch, and is ranked as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified include climate changes and regime shifts (see Section 3.5.1.21).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey availability are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for the habitat suitability of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on habitat suitability are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for GOA arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

4.6.1.9 Greenland Turbot and Deepwater Flatfish

BSAI Greenland turbot and GOA deepwater flatfish are described in more detail in Sections 3.5.1.9 and 3.5.1.22 of this Programmatic SEIS. Greenland turbot is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category; thus MSSTs are defined for these species. The reference fishing mortality rate and ABC for the GOA deepwater flatfish management group are determined by the amount of population information available. ABCs for Dover sole were calculated using Tier 5. Greenland turbot and deepsea sole are in Tier 6 because no reliable biomass estimates exist.

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 2.1

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 2.1, model projections indicate that the total BSAI biomass is expected to decline 39 percent of the 2002 value to 64,000 mt by 2007, with a 2003-2007 average value of 77,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-5 and Figure H.4-4 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to decline 57 percent of the 2002 value to 29,300 mt by 2007, with a 2003-2007 average value of 42,500 mt. Projected female spawning biomass is estimated to decline below the B_{MSY} proxy value of 47,570 mt (after five years of harvest at the F_{MSY} value) by the end of the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Model projections show this value will increase to 0.483 for each year of the projection through 2007. This level of harvest is at, but does not exceed the F_{MSY} proxy value, the rate associated with the OFL (Table H.4-5 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI Greenland turbot harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.), although these locations are shallow areas which are not habitat for adult Greenland Turbot. In addition, they may fish in areas they purposefully avoided in the baseline year due to high bycatch rates.

Status Determination

Model projections of future catches of BSAI Greenland turbot do not exceed the OFL in 2003-2007 under FMP 2.1. However, the female spawning stock is below the MSST level during the five year projection under the FMP 2.1 harvest scenario. The Greenland turbot stock is above the MSST level in the baseline year 2002.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.1 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 on Greenland turbot would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1.

Summary of Effects of FMP 2.1 – BSAI Greenland Turbot

Under FMP 2. 1, the spawning stock biomass of BSAI Greenland turbot is expected to be below the MSST. The fishing mortality rate does not exceed $F_{OFL,}$ but the stock is expected to fall below the MSST. Therefore the expected changes under this FMP are substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, there are significantly adverse direct effects on the change in reproductive success, genetic structure and the change in biomass under this FMP. The other direct and indirect effects are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to be overfished under this FMP. The 20 year projection (Figure H.4-4 of Appendix H) indicates that the female spawning stock is expected to decline until 2007 to below B_{MSY} levels and will increase thereafter through the end of the projection but still remain below the B_{MSY} spawning stock level in 2023.

Cumulative Effects of FMP 2.1

Cumulative effects for BSAI Greenland turbot are summarized in Table 4.5-15.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 2.1 since the projected fishing mortality rates are at the OFL for this stock.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is at the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI Greenland turbot biomass is significantly adverse.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the Greenland turbot biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.9 and 3.10.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot, and is rated as significantly adverse. The female spawning biomass level is projected to fall below the B_{MSY} proxy value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is likely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 the effect of the spatial/temporal concentration of catch is considered significantly adverse for the stock.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the spatial/temporal concentration of BSAI Greenland turbot catch. Climate changes and regime shifts are suspected of having an effect on the reproductive success of the Greenland turbot stock (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Greenland turbot catch and is rated as significantly adverse. The expected changes under FMP 2.1 are substantial enough to expect that the reproductive success and genetic structure of the spawning stocks would be affected. The combined effect of internal removals and removals due to reasonably foreseeable external events is likely to sufficiently alter the genetic structure and the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI Greenland turbot stock. Past foreign, JV, and domestic fisheries have been identified as having influenced the availability of Greenland turbot prey, mainly pollock which is their main prey item in the BSAI. Climate changes and regime shifts have also been identified as influencing Greenland turbot prey availability (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI Greenland turbot include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of Greenland turbot, largely through the impacts of fishing gear on benthic habitats (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Greenland turbot habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Greenland turbot stock to sustain itself at or above the MSST is jeopardized.

GOA Deepwater Flatfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The catch of GOA deepwater flatfish in 2002 was estimated to be 600 mt. Model projections of future catch are shown in Table H.4-25 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to increase over four times the 2002 value to 2,400 mt by 2007, with a 2003-2007 average value of 2,600 mt. Under FMP 2.2, model projections indicate that the catch is expected to increase twice the 2002 value to 1,200 mt by 2007, with a 2003-2007 average value of 1,200 mt.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual GOA deepwater flatfish harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA deepwater flatfish fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual this fishery would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 5 or Tier 6 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratio of deepwater flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on deepwater flatfish would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Deepwater Flatfish

The direct and indirect effects of FMP 2.1 and FMP 2.2 on GOA deepwater flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five year projection and what level of fishing mortality corresponds to the modeled catch estimated under these FMPs (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA deepwater flatfish are summarized in Table 4.5-16.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deepwater flatfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA deepwater flatfish stock.

- **Reasonably Foreseeable Future External Effects.** Past effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of deepwater flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA deepwater flatfish and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Total and spawning biomass estimates are unavailable for the deepwater flatfish species, therefore, the effects of FMP 2.1 and FMP 2.2 on the change in biomass level are unknown.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA deepwater flatfish stock complex.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the deepwater flatfish species biomass level. For more information on climate changes and regime shifts (see Sections 3.5.1.22 and 3.10). The State of Alaska scallop fishery has been identified as a non-contributing factor for change in biomass level since deepwater flatfish species bycatch is not expected to occur.

- **Cumulative Effects.** Cumulative effects are possible for the change in biomass level of GOA deepwater flatfish, but is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown for the stock since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts which are suspected of having an effect on the reproductive success of the deepwater flatfish stock complex (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of GOA deepwater flatfish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor to change in genetic structure and reproductive success since bycatch of GOA deepwater flatfish species is not expected to occur.

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration of the GOA deepwater flatfish catch; however, this effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Paste effects are identified for the change in prey availability of the GOA deepwater flatfish stock complex and include climate changes and regime shifts (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery has been identified as a potential adverse contributor to benthic prey availability (see Section 3.6).

- **Cumulative Effects.** A cumulative effects is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to maintain current populations.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Past effects identified for GOA deepwater flatfish include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of deepwater flatfish, largely through the impacts of fishing gear on benthic habitats (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery has been identified as a potential adverse contributor to habitat suitability (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is identified for GOA deepwater flatfish habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the deepwater flatfish stock complex to maintain current population levels is jeopardized.

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 2.2

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to decline about 19 percent of the 2002 value to 86,000 mt by 2007, with a 2003-2007 average value of 91,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 2.2, model projections indicate that female spawning biomass is expected to decline 31 percent of the 2002 value to 46,600 mt by 2007, with a 2003-2007 average value of 53,800 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,570 mt for 2003-2006 and then drop 930 mt below the B_{MSY} proxy value in 2007.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Model projections show this value will increase to 0.19 in 2003 and 2004 and then decrease to 0.16 in 2007. This maximum value under this FMP is less than the F_{MSY} proxy value of 0.48, the rate associated with the OFL (Table H.4-5 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Since this FMP allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that Greenland turbot fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual BSAI Greenland turbot harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

Model projections of future catches of BSAI Greenland turbot are below the OFLs in all years under FMP 2.2. The Greenland turbot female spawning stock is above the MSST level under this FMP, as in the baseline year 2002.

Age and Size Composition

Under FMP 2.2, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.6 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50.No information is available to suggest that this would change under FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.2 on Greenland turbot would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.2.

Summary of Effects of FMP 2.2 – BSAI Greenland Turbot

Under FMP 2.2, the spawning stock biomass of BSAI Greenland turbot is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stock is expected to remain above the MSST, the expected changes under this FMP are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under this FMP are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to continue to not be overfished under this Alternative. The 20 year projection (Figure H.4-4 of Appendix H) indicates that the female spawning stock is expected to decline until 2007 to B_{MSY} levels and will increase thereafter through the end of the projection to above B_{ABC} spawning stock levels in 2023.

Cumulative Effects of FMP 2.2

Cumulative effects for BSAI Greenland turbot are summarized in Table 4.5-15.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** External effects on mortality are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI Greenland turbot biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the female spawning biomass is above the B_{MSY} value from 2003-2006. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.2 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects identified for the spatial/temporal concentration of BSAI Greenland turbot are the same as those described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of Greenland turbot are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Greenland turbot catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.2, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for the change in prey availability of the BSAI Greenland turbot are the same as those described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for the habitat suitability of BSAI Greenland turbot are the same as those described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on habitat suitability are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Greenland turbot habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Greenland turbot stock to sustain itself at or above the MSST is jeopardized.

4.6.1.10 Alaska Plaice and Other Flatfish and Rex Sole

BSAI Alaska plaice and other flatfish and GOA rex sole fisheries are described in more detail in Sections 3.5.1.10 and 3.5.1.23 of this Programmatic SEIS.

BSAI Alaska Plaice – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

Total biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 1,083,000 mt. Model projections of future total Alaska plaice BSAI biomass are shown in Table H.4-9 of Appendix H. Under FMP 2.1, model projections indicate that BSAI biomass is expected to increase to a value of 1,098,000 mt in 2007, with a 2003-2007 average value of 1,089,000 mt. Under FMP 2.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,112,000 mt in 2008, with a 2003-2008 average value of 1,097,000 mt.

Spawning Biomass

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 274,800 mt. Model projections of future total BSAI biomasses are shown in Table H.4-9 and Figure H.4-8 of Appendix H. Under FMP 2.1, model projections indicate that BSAI Alaska plaice biomass is expected to decrease to a value of

270,700 mt in 2005, and then increase to 273,200 mt in 2007. The projected average biomass from 2003-2007 is 272,400 mt. Under FMP 2.2, model projections indicate that BSAI Alaska plaice biomass is expected to decrease to a value of 273,200 mt in 2005 and increase to 279,300 mt in 2008, with a 2003-2008 average value of 275,400 mt.

Fishing Mortality

Under FMP 2.1, the projected fishing mortality imposed on the BSAI Alaska plaice stock is 0.032 in 2003, and decreases to 0.026 in 2007. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 86 percent in 2003 and increases to 88 percent in 2007, with an average of 87 percent from 2003-2007 (Table H.4-9 of Appendix H).

Under FMP 2.2, the projected fishing mortality imposed on the BSAI Alaska plaice stock is approximately 0.027 in 2003, decreasing to 0.021 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 88 percent in 2003 and increases to 90 percent in 2008, with an average of 89 percent from 2003-2008 (Table H.4-9 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 involves the resumption of fishing in a number of areas currently closed, and these areas are largely in the EBS. Although most of the bycatch of Alaska plaice still occurs in the yellowfin sole fishery, a greater proportion is taken in the Pacific cod trawl fishery. An average of 17,800 mt was projected to be annually harvested from 2003-2008, with 10,710 mt (60 percent) from the yellowfin sole fishery and 4,040 mt (22 percent) from the Pacific cod trawl fishery.

Under FMP 2.2, the average projected catch from 2003-2008 is 13,000 mt, of which 9,500 mt (73 percent) occurred in the EBS shelf yellowfin sole fishery and 1,900 mt (14 percent) occurred in the EBS shelf rock sole fishery.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL, removing the buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below the OFL level from 2003 to 2008.

Under FMP 2.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below ABC and OFL levels from 2003 to 2008.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections, is 4.36 years. Under FMP 2.2, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections (Table H.4-9 of Appendix H), is 4.38 years. This compares with a mean age in the equilibrium unfished stock of 4.51 years.

Sex Ratio

The sex ratio of BSAI Alaska plaice is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 and FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 2.1 and FMP 2.2.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Alaska Plaice

Although the ABC and OFL levels for Alaska plaice are equivalent under FMP 2.1, and the F_{OFL} is not reduced for lower stock sizes, the harvest of Alaska plaice under FMP 2.1 is reduced so the direct and indirect effects are considered insignificant. Fishing rates are at the $F_{85\%}$ level, which are lower than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment.

Because the BSAI Alaska plaice are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 2.2 are considered insignificant. Fishing rates are lower than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Relative to the 2002 comparative baseline, the Alaska plaice stock is projected to continue to not be overfished under this FMP. The twenty year projection (Figure H.4-8 of Appendix H) indicates that the female spawning stock is expected to remain at a high and stable level well above B_{ABC}.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI Alaska plaice are summarized in Table 4.5-17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Alaska plaice stock is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor to mortality of BSAI Alaska plaice. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as contributors to mortality since a change is not expected to be significant in magnitude to cause mortality.

- **Cumulative Effects.** Under FMP 2.1 and FMP 2.2, a cumulative effect is identified for BSAI Alaska plaice mortality; however, that effect is considered insignificant. Alaska plaice are fished above the ABC and OFL values. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the BSAI Alaska plaice stock is expected to be insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution events are identified as potential adverse contributors to BSAI Alaska plaice change in biomass level. Acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to change in biomass level, since recruitment is affected by climate changes and regime shifts through a combination of prey availability and habitat suitability effects.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Alaska plaice change in biomass; however, it is determined to be insignificant. The combination of internal and external factors are not expected to reduce Alaska plaice biomass such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 are determined to have an insignificant effect on BSAI Alaska plaice spatial/temporal characteristics.

- **Persistent Past Effects.** No persistent past effects have been identified for the genetic structure of the BSAI Alaska plaice population. Although, climate changes and regime shifts have been identified as having a potential beneficial or adverse effect on BSAI Alaska plaice reproductive success.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contribution to BSAI Alaska plaice genetic structure and reproductive success. Acute and/or chronic events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and could also result in reduced recruitment. Climate changes and regime shifts have been identified as potential beneficial or adverse contributor to the reproductive success of BSAI Alaska plaice, but as a non-contributing factor to the genetic structure of Alaska plaice. The reproductive success is affected through a combination of climate induced changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect has been identified for the spatial/temporal concentration of BSAI Alaska plaice; however, it is determined to be insignificant. The combined internal and external events are not expected to significantly alter the reproductive success or genetic structure such that it jeopardizes the capacity of the stock to maintain itself above MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 is determined to have an insignificant effect on BSAI Alaska plaice prey availability.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having potential adverse or beneficial effects on BSAI Alaska plaice prey availability. Little research has been conducted on benthic invertebrates, the main prey species of Alaska plaice, therefore the magnitude and direction of the effects imposed by climate changes and regime shifts are unknown.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor to the prey availability of BSAI Alaska plaice. Acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above the MSST. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to BSAI Alaska plaice prey availability. However, as stated above, since little research has been conducted on the effects of climate changes on benthic invertebrates, the magnitude and direction of the changes are unknown.

- **Cumulative Effects.** A cumulative effect has been identified for the BSAI Alaska plaice change in prey availability; however, the effect is identified as insignificant. The combination of internal and external removals of prey species is not expected to decrease prey availability such that the BSAI Alaska plaice stock is unable to maintain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 is determined to have an insignificant effect on Alaska plaice habitat suitability.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries have been identified as having adverse effects on BSAI Alaska plaice habitat. See Sections 3.5.1.10 and 3.6 for more information on the effects of fishing gear on flatfish habitat. Climate changes and regime shifts are also identified as having a potential adverse or beneficial effect on Alaska plaice habitat (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to BSAI Alaska plaice habitat suitability. Acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success of Alaska plaice. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions to BSAI Alaska plaice habitat suitability. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment is favored.

- **Cumulative Effects.** A cumulative effect for BSAI Alaska plaice change in habitat suitability is identified and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the BSAI Alaska plaice stock to maintain itself at or above the MSST is jeopardized.

BSAI Other Flatfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass

Total and spawning biomass estimates are not available for these species.

Fishing Mortality

The catch of BSAI other flatfish in 2002 was estimated to be 2,600 mt. Model projections of future catch are shown in Table H.4-10 of Appendix H. Under FMP 2.1, model projections indicate that the 2003 catch is expected to increase from the 2002 value to 3,300 mt in 2003 and then gradually decrease each year to 2,800 mt in 2007 (7 percent increase from 2002). The 2003-2007 average catch is 3,000 mt. Under FMP 2.2, model projections indicate that the catch is expected to increase 18 percent from the 2002 value to 3,100 mt in 2003 and then decrease to 2,800 mt in 2007 (3 percent increase from 2002). The 2003-2007 average catch is 2,700 mt.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI Other flatfish harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.) or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that Other flatfish fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of their harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratios the species of the Other flatfish category in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on other flatfish would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1of FMP 2.2 – BSAI Other Flatfish

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI other flatfish are summarized in Table 4.5-18.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for BSAI other flatfish mortality.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other flatfish and is rated as insignificant. Fishing mortality rates for projected years are well below the other flatfish OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Past effects have not been identified for the BSAI other flatfish change in biomass level effect indicator.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other flatfish, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the spatial/temporal concentration of catch are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics of the BSAI other flatfish stock are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other flatfish catch; however, these effects are unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the change in prey availability are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for the change in prey availability are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for habitat suitability of BSAI other flatfish are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for habitat suitability of BSAI other flatfish are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for BSAI other flatfish habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

GOA Rex Sole – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass

Total and spawning biomass estimates are not available for this species.

Fishing Mortality

The catch of GOA rex sole in 2002 was estimated to be 3,000 mt. Model projections of future catch are shown in Table H.4-26 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to increase to 9,300 mt in 2003 and remain at 9,200 for 2004-2007. The 2003-2007 average catch is 9,300 mt. Under FMP 2.2, model projections indicate that the catch is expected to increase to 3,400 mt in 2004 and then decrease to 3,200 mt by 2007. The 2003-2007 average catch is 3,300 mt.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual GOA rex sole harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA rex sole fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual GOA rex sole harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information for GOA rex sole requires that they are classified into the Tier 5 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for this species.

Sex Ratio

The sex ratio of rex sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on rex sole would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Rex Sole

Except for the effects of mortality, the direct and indirect effects of FMP 2.1 and FMP 2.2 on GOA rex sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of this stock is over the five year projection and what level of fishing mortality corresponds to the modeled catch estimated under these FMPs. The projected catch for both FMPs are under the OFL for all projected years, therefore FMP 2.1 and FMP 2.2 is expected to have insignificant effects of GOA rex sole through mortality (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for rex sole are summarized in Table 4.5-19.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA rex sole stocks. See Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rex sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA rex sole and is rated as insignificant. Fishing mortality rates for projected years are well below the rex sole OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Large removals of rex sole by past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA rex sole stocks see Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potential beneficial or adverse effect on the rex sole biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. The State of Alaska Scallop Fishery is identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole. For more information on climate changes and regime shifts see Sections 3.5.1.23 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA rex sole, but is rated as unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects are not identified for genetic structure of the population; however, climate changes and regime shifts are identified as having persistent past effects on the reproductive success of the GOA rex sole stock. See Sections 3.5.1.23 and 3.10 for more information of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the genetic structure of rex sole include the potential adverse effects of marine pollution since an acute and/or chronic pollution event could alter the genetic structure of the population by causing localized mortality. The State of Alaska scallop fishery and climate changes and regime shifts have both been identified as non-contributing factors to the change in genetic structure of rex sole stocks. These events are not expected to cause localized depletions that would alter the genetic sub-population structure of rex sole stock. Change in reproductive success of rex sole due to climate changes and regime shifts are identified as having a potential beneficial or adverse effect. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could also the reproductive success of GOA rex sole. Again, the State of Alaska scallop fishery has been identified as a non-contributing factor since the scallop fishery is not expected to contribute to rex sole removals.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rex sole catch; however, this effect is unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts are identified as having had effected the prey availability of the GOA rex sole stock. The actual effect of climate changes and regime shifts on rex sole prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.23 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Past effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The State of Alaska scallop fishery has been identified as having a potential adverse effect on rex sole prey availability since the habitat disturbances caused by dredging could influence the availability of benthic prey.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for GOA rex sole include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the GOA rex sole stock see Sections 3.5.1.23 and 3.10 for more information regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as having potential adverse effects on rex sole habitat suitability that may cause changes in the spawning or rearing success of the stock.

- **Cumulative Effects.** A cumulative effect is possible for GOA rex sole habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

4.6.1.11 Pacific Ocean Perch

Pacific ocean perch (*Sebastes alutus*) are managed under Tier 3 in both the BSAI and GOA. Sections 3.5.1.11 and 3.5.1.24 discuss the past/present analysis in further detail.

BSAI Pacific Ocean Perch – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

<u>Total Biomass</u>

Total biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 374,000 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 of Appendix H. Under FMP 2.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to decrease to a value of 360,000 mt in 2008, with a 2003-2008 average value of 366,000 mt. Under FMP 2.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 383,000 mt in 2008, with a 2003-2008 average value of 379,000 mt.

<u>Spawning Biomass</u>

Spawning biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 134,700 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 and Figure H.4-10 of Appendix H. Under FMP 2.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to decrease to a value of 122,400 mt in 2008, with a 2003-2008 average value of 127,700 mt. Under FMP 2.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to decrease to a value of 133,100 mt in 2005 and remain at this level through 2008, with a 2003-2008 average value of 133,600 mt.

Fishing Mortality

Under FMP 2.1, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock in each year from 2003 to 2008 is 0.057, which is equivalent to the $F_{35\%}$ proxy for the overfishing rate. At this fishing mortality rate, 35 percent of the spawner biomass per recruit would be conserved (Table H.4-12 of Appendix H).

Under FMP 2.2, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is approximately 0.040 from 2003 to 2006, increasing to 0.042 in 2007 and 2008. The proportion of spawner per recruit biomass conserved under these fishing mortality rates is 45 percent in 2003, increasing to 46 percent in 2005, and decreasing to 44 percent in 2008, with an average of 45 percent from 2003-2008 (Table H.4-12 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Although FMP 2.1 involves the resumption of fishing in a number of areas currently closed, these areas are largely in the EBS. Over the projection years 2003 to 2008 an average of 800 mt (of 17,700 mt total BSAI Pacific ocean perch catch) are taken annually as bycatch in Bering Sea fisheries, and an average of 11,900 mt are taken by the central Aleutian Islands Pacific ocean perch fishery.

Under FMP 2.2, the proportion of catch occurring in the eastern Aleutian Islands is increased relative to baseline conditions. The average projected catch from 2003-2008 is 13,100 mt, of which 7,700 mt (59 percent) occurred in the eastern Aleutian Islands. This catch is taken largely from directed Pacific ocean perch fisheries, although the Atka mackerel fishery is projected to harvest an average of 200 mt of Pacific ocean perch in each year from 2003 to 2008.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL, removing the buffer between these two harvest regulations. Under FMP 2.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are at the OFL level from 2003 to 2008, and projected spawning stock biomass is above B_{MSY} ($B_{35\%}$) level of 120,200 mt. Thus, BSAI Pacific ocean perch are determined to be above the MSST level for the projection years of 2003-2008 for both FMPs.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections, is 9.93 years. Under FMP 2.2, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-12 of Appendix H), is 10.23 years. This compares with a mean age in the equilibrium unfished stock of 14.01 years.

Sex Ratio

The sex ratio of BSAI Pacific ocean perch is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.1 or FMP 2.2. However, because BSAI Pacific ocean perch are determined to be above the MSST for the projection years, at they are fished at or above the OFL under these FMPs, FMP 2.1 and FMP 2.2 are determined to have an insignificant effect through habitat suitability.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, because Pacific ocean perch feed mainly on euphausiid species, which are not caught within the groundfish fisheries, the direct and indirect effects of FMP 2.1 and FMP 2.2 are expected to be insignificant through prey availability.

Summary of Effects of FMP 2.1and FMP 2.2 – BSAI Pacific Ocean Perch

Under FMP 2.1, BSAI Pacific ocean perch are fished at rates equal to F_{OFL}, or $F_{35\%}$,, which is somewhat higher than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. However, the spawning biomass remains above the $B_{35\%}$ level, which is taken as a proxy for Bmsy. Thus, the direct and indirect effects under FMP 2.1 are considered insignificant. The removal of closed areas to fishing in the Bering Sea has little effect on the spatial distribution of the catch in this area, as little Pacific ocean perch are taken in Bering Sea fisheries. However, a fairly large proportion, 67 percent, of the Pacific ocean perch are harvested in the cental Aleutian Islands.

Because the BSAI Pacific ocean perch are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 2.2 are considered insignificant. Fishing rates are within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI Pacific ocean perch are summarized in Table 4.5-20.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to BSAI Pacific ocean perch mortality since bycatch in this fishery is not expected. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific ocean perch mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at levels equal to the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific ocean perch stock is expected to be insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute significantly to BSAI Pacific ocean perch mortality since bycatch is not expected in this fishery. Therefore, the IPHC longline fishery is also not expected to cause significant changes in biomass levels. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to Pacific ocean perch change in biomass levels as a function of reproductive success.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>

   – Change in Genetic Structure of Population
   – Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific ocean perch population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.11) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery are not expected to contribute to changes in genetic structure or reproductive success of BSAI Pacific ocean perch since bycatch of BSAI Pacific ocean perch is not expected to occur. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. Generally, changes in climate changes that lead to increased advection of the Alaska current are believed to increase euphausiid production, a major prey item of BSAI Pacific ocean perch. Climate changes and regime shifts are not considered to contribute to changes in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific ocean perch prey species (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific ocean perch prey species are identified as potential beneficial or adverse contributors. In general, it is believed that climate changes and regime shifts that lead to the increased advection of the Alaska current also increase production of euphausiids, a major prey item of BSAI Pacific ocean perch. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for BSAI Pacific ocean perch stocks include past foreign, JV, and domestic fisheries, IPHC longline fisheries and climate changes and regime shifts (see Section 3.5.1.11). Intense bottom trawling on Pacific ocean perch habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries are also identified as having adverse effects on Pacific ocean perch habitat, although these fishing gear impacts are considered to be less significant than those associated with trawl gear (see Section 3.6). Climate changes and regime shifts have had both beneficial and adverse effects on Pacific ocean perch habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is identified as making adverse contributions to Pacific ocean perch habitat through fishing gear impacts. As stated above, these impacts are expected to be of lesser magnitude than those effects associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific ocean perch stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

GOA Pacific Ocean Perch – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass and Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management. An important measure in this bookend that would impact all target species is that ABC would be set equal to overfishing. This would eliminate the buffer between ABC and overfishing that exists in FMP 1. Also under FMP 2.1 the eastern GOA trawl closure in FMP 1 would be repealed. Both of these measures in combination would likely result in a larger catch of GOA Pacific ocean perch than has been the case in years past, and increase the risk of overfishing GOA Pacific ocean perch stocks. The bycatch model results for this bookend show increased catches for GOA Pacific ocean perch and therefore appear to be reasonable. Average fishing mortality during the years 2003 - 2008 is expected to be equal to F_{OFL} (0.060) (Table H.4-36 and Figure H.4-15 of Appendix H).

FMP 2.2 is much less aggressive in its approach than FMP 2.1. The two particular measures that impacted GOA Pacific ocean perch catch in FMP 2.1 are not part of FMP 2.2, so catch of GOA Pacific ocean perch in FMP 2.2 should be reduced relative to FMP 2.1 and result in catches similar to those of FMP 1. Bycatch model results for FMP 2.2 show catches comparable to FMP 1 for GOA Pacific ocean perch and therefore appear reasonable. Average fishing mortality during the years 2003 - 2008 is expected to be less than F_{OFL} (0.060).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1 the eastern GOA trawl closure in FMP 1 would be repealed. Under FMP 2.1, trawl fishing is permitted in the southeast/east Yakutat area and the ABC (12 percent of the total GOA ABC) normally allocated to that area would now likely to be caught.

The effect of FMP 2.1 on the spatial/temporal concentration of Pacific ocean perch catch is similar to what the baseline situation has been in past years. A major difference of FMP 2.1 versus the baseline for Pacific ocean perch would be the inclusion of the eastern GOA as an open trawl zone. ABC is apportioned by area and inclusion of the eastern GOA would spread effort out resulting in more protection against localized depletion. Fishing effort would continue to be compressed into a relatively short open season especially if high concentrations of Pacific ocean perch are harvested in the eastern GOA. This may result in increasing the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

FMP 2.2 would have similar effects on the spatial and temporal concentration of Pacific ocean perch catch as the baseline fishing. The inclusion of the eastern Gulf no-trawl zone is consistent with the baseline situation. ABCs are geographically apportioned among management areas which provides some protection against localized depletion. The Pacific ocean perch fishery would likely be concentrated into a relatively short open season, thereby increasing the risk of possible overfishing because of the difficulty of managing a short compressed fishery.

Status Determination

Under FMP 2.1, the projected B2003 of 111,900 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B2005 of 106,400 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Under FMP 2.2, the projected B2003 of 112,800 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B_{2005} of 112,800 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition

Under FMP 2.1 and FMP 2.2, the age composition of GOA Pacific ocean perch may be affected by fishing mortality as in FMP 1. No information is available to suggest that sex ratio would change under these FMPs, but the size composition of GOA Pacific ocean perch might change in proportion to the change in age composition.

Sex Ratio

No information is available to suggest that the sex ratio would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Under FMP 2.1 increased damage to epifauna by increased bottom trawl effort, and the opening of the eastern GOA to bottom trawling may adversely impact the habitat of juvenile Pacific ocean perch. FMP 2.1 also adversely impacts GOA Pacific ocean perch because by opening the eastern GOA to trawling it removes a *de facto* no take zone or refugium for Pacific ocean perch in this area which could reduce the reproductive potential of the stock. However, these impacts on habitat suitability are predicted to be insignificant because the GOA Pacific ocean perch stock is determined to remain above the MSST for all projection years.

Under FMP 2.2 damage to epifauna by bottom trawls may adversely impact juvenile Pacific ocean perch habitat. However, FMP 2.2 may reduce the impacts on habitat for GOA Pacific ocean perch by maintaining the eastern GOA closure to trawling. This provides a *de facto* no take zone or refugium for Pacific ocean perch in this area and provides protection from the potential effects of trawling on adult and juvenile rockfish habitat.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, because Pacific ocean perch feed mainly on euphausiid species, which are not caught within the groundfish fisheries, the direct and indirect effects of FMP 2.1 and FMP 2.2 are expected to be insignificant through prey availability.

Summary of Effects of FMP 2.1 and FMP 2.2 – GOA Pacific Ocean Perch

Under FMP 2.1 and FMP 2.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 2.1 and FMP 2.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability. For further detail on the past/present effects analysis for GOA Pacific ocean perch, see Section 3.5.1.24 (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA Pacific ocean perch are summarized in Table 4.5-21.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at or below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific ocean perch stock is expected to be insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** The impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of GOA Pacific ocean perch and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for prey availability; however, the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST. Therefore, the cumulative effect of FMP 2.1 and FMP 2.2 on GOA Pacific ocean perch is considered insignificant through prey availability.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have insignificant effects on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its effect on the GOA Pacific ocean perch stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

4.6.1.12 Thornyhead Rockfish

GOA thornyhead rockfish are described in more detail in Section 3.5.1.23 of this Programmatic SEIS. Until recently, thornyhead rockfish were managed as its own stock under the GOA groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2004, thornyhead rockfish will be managed under Tier 5. GOA thornyhead rockfish were modeled under the Tier 3 category for this analysis.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

<u>Total Biomass</u>

Total (ages 5 through 55+) biomass of GOA thornyheads at the start of 2002 is estimated to be 54,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-37 of Appendix H. Under FMP 2.1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly decrease to a value of 53,000 mt by 2007, with a 2003-2007 average value of 53,000 mt. Under FMP 2.2, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly increase to a value of 55,000 mt by 2007, with a 2003-2007 average value of 54,000 mt.

<u>Spawning Biomass</u>

Spawning biomass of female GOA thornyheads at the start of 2002 is estimated to be 23,500 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-37 and Figure H.4-16 of Appendix

H. Under FMP 2.1, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and decreasing to 23,200 mt by 2007, with a 2002-2007 average value of 23,400 mt. Under FMP 2.2, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and increasing to 24,300 mt by 2007, with a 2002-2007 average value of 23,900 mt.

Fishing Mortality

The average fishing mortality imposed on the GOA thornyhead stock in 2002 is projected to be 0.032 under current management. Under FMP 2.1, fishing mortality is projected to increase to 0.037 in 2003 and decrease back to 0.032 in 2007. Under FMP 2.2, fishing mortality is projected to decrease to 0.025 in 2003 and decrease further to 0.020 in 2007. These values are well below the F_{MSY} proxy value of 0.102 which is the rate associated with the OFL.

Spatial/Temporal Concentration of Fishing Mortality

Thornyhead catch is approximately evenly divided between longliners and trawlers under status quo management. There is nothing about FMP 2.1 or FMP 2.2 that is expected to change this. Longline catches are spatially dispersed along the continental shelf break throughout the GOA (Figure 4.5-1), and temporally dispersed due to the nature of the IFQ sablefish fishery. For example, longline thornyhead catches in 2000 occurred year round, with peaks in April and September which did not exceed 60 mt per week. Trawler catch has been more concentrated in time, with some catches of 20-40 mt per week happening in late spring and a single large peak of 160 mt per week in 2000 during July, coincident with the rockfish trawl fishery. Between 1997 and 1999, trawl thornyhead catches appear to have become more concentrated in space (Figure 4.5-2). The distribution of thornyheads from surveys did not appear to change over the same time period (Figure 4.5-3). This apparent concentration may be the indirect result of changes in the trawl fisheries for deepwater flatfish and rockfish since thornyheads are not a primary target of trawl fisheries. However, it should be noted that the overall catch of thornyheads is low relative to both the estimated biomass and the ABC, such that this apparent concentration of catch is unlikely to have any adverse population effects.

Status Determination

The GOA thornyhead stock is not overfished. Even at the projected low point under FMP 2.1 of 23,200 mt, spawning stock biomass is expected to be well above both $B_{35\%}$ level (14,681 mt) as well as the $B_{40\%}$ level (16,045 mt), and will remain above $B_{40\%}$ in all projection years under FMP 2.1. At 23,500 mt, spawning stock biomass under FMP 2.2 is also expected to be well above both $B_{35\%}$ level (14,681 mt) as well as the $B_{40\%}$ level (16,045 mt) in the year 2002 and will remain above $B_{40\%}$ in all projection years under FMP 2.2.

Age and Size Composition

Under FMP 2.1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 9.90 years. Under FMP 2.2, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.15 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.67 years.

Sex Ratio

The sex ratio of GOA thornyheads is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Under FMP 2.1, all current closed areas aside from those related to sea lion habitat would be removed. However, most current closed areas do not extend to deeper waters where thornyheads are found. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Under FMP 2.2, all current management measures would be maintained. The level of habitat disturbance under FMP 1 (and FMP 2.2) does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next five years under this alternative.

Prey Availability

In the GOA, shortspine thornyheads prey on benthic invertebrates; according to the AFSC food habits database, much of their diet in the 1990s has been composed of shrimp. Thornyheads are rare in the diets of other groundfish, birds, or marine mammals in the GOA according to the present limited information. Therefore, the effects of FMP 2.1 and FMP 2.2 on trophic interactions involving GOA thornyheads are expected to be minor. The current levels and distribution of groundfish harvest do not appear to impact prey availability for thornyheads such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Thornyhead Rockfish

The GOA thornyhead stock appears to be healthy and stable under current management, and catches have generally been below the estimated ABCs because thornyheads are taken as bycatch in other directed fisheries. To the best of our knowledge, thornyheads are widely distributed in the deeper habitats of the GOA, where fishing impacts have historically been low. As long as catches remain at or near the currently observed low levels, as predicted under FMP 2.1 and FMP 2.2, we do not expect any significant population effects to thornyheads (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA thornyhead rockfish are summarized in Table 4.5-22.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. The removals of thornyhead rockfish that occurred in these fisheries have had a lingering adverse effect on the populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of thornyhead rockfish. The IPHC longline fishery is identified as a potential adverse contributor to thornyhead rockfish mortality since they are caught as bycatch in this fishery. However, the State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA thornyhead rockfish and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** FMP 2.1 or FMP 2.2 is expected to have insignificant effects on GOA thornyhead rockfish through the change in biomass levels.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. Past removals by these fisheries have had a lingering adverse effect on the GOA thornyhead rockfish populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the thornyhead rockfish biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.23 and 3.10). The IPHC longline fishery is identified as a potential adverse contributor to the thornyhead rockfish biomass level since they are caught as bycatch in this fishery. The State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA thornyhead rockfish and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA thornyhead rockfish. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of GOA thornyhead rockfish. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the thornyhead rockfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of thornyhead rockfish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA thornyhead rockfish. The IPHC longline fishery removals could be sufficiently concentrated as to alter the genetic structure and reproductive success of GOA thornyhead rockfish populations and is therefore identified as a potential adverse contributor. The State of Alaska shrimp fishery is identified as a non-contributing factor since bycatch of thornyhead rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the thornyhead rockfish catch and is ranked as insignificant. The spatial/temporal distribution of thornyhead rockfish catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in prey availability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some prey species (i.e. shrimp); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor since bycatch of GOA thornyhead rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to prey availability since removal of shrimp, the main prey species of GOA thornyhead rockfish, occurs in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.1, the change in habitat suitability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA thornyhead rockfish include climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery has been identified as a potential adverse contributor to GOA thornyhead rockfish habitat suitability (see Section 3.6). The State of Alaska shrimp fishery is identified as a non-contributing factor since habitat degradation by the shrimp fishery gear is not expected to occur.

- **Cumulative Effects.** A cumulative effect is identified for GOA thornyhead rockfish habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the thornyhead rockfish stock to sustain itself at or above the MSST is jeopardized.

4.6.1.13 Rockfish

BSAI and GOA rockfish are described in more detail in Sections 3.5.1.12-3.5.1.14 and 3.5.1.24.

BSAI Northern Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Until recently, BSAI northern rockfish were managed under Tier 5; beginning in 2004, northern rockfish will be managed under Tier 3. BSAI northern rockfish were modeled under the Tier 5 category for this analysis.

<u>Total and Spawning Biomass</u>

Reliable estimates of total and spawning biomass are not available for this species.

<u>Fishing Mortality</u>

The catch of BSAI northern rockfish in 2003 was estimated as 6,800 mt. Projected catches from 2003-2008 are shown in Table H.4-15 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to decrease to 4,900 mt in 2005, then increase to 5,200 mt in 2008. The 2003-2008 average catch is 5,400 mt. Under FMP 2.2, model projections indicate that the catch is expected to decrease to 6,400 mt in 2006, then increase to 6,600 mt in 2008. The 2003-2008 average catch is 6,800 mt.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1, model projections indicate that the average harvest of 5,400 mt from 2003-2008 occurs largely in the western Aleutian Islands (3,700 mt, 68 percent), with 800 mt (14 percent) occurring in the EBS and 700 mt (13 percent) occurring in the central Aleutians. The harvest of northern rockfish in the western Aleutian Islands is taken largely in the Atka mackerel fishery, whereas the harvest in the EBS and central Aleutians are taken in the Pacific cod and Pacific ocean perch fisheries, respectively.

Under FMP 2.2, model projections indicate that the average harvest of 6,800 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (4,700 mt, 68 percent), with 1,300 mt (19 percent) occurring in the central Aleutian Islands. The harvest of northern rockfish in the each of these areas is taken largely in the Atka mackerel fishery.

Status Determination

Under FMP 2.1, the ABC for northern rockfish is set equal to the OFL. Under FMP 2.2, the catch rates are below the ABC and OFL values for all years. The MSST cannot be determined for this species.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for this species. The sex ratio of BSAI northern rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – BSAI Northern Rockfish

Under FMP 2.1, the ABC for northern rockfish is set equal to the OFL. An age-structured population model for BSAI northern rockfish is not available, and projections of future OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI northern rockfish are equal to the OFL and the effects of mortality under FMP 2.1 are considered insignificant. Under FMP 2.2, BSAI northern rockfish are fished at less than the ABC and the effects of mortality under FMP 2.2 are considered insignificant. Since the MSST is not able to be calculated, the spatial/temporal distribution of catch and other direct/indirect effects are unknown (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI northern rockfish are summarized in Table 4.5-23.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of northern rockfish. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI northern rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the northern rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI northern rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI northern rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI northern rockfish (see Section 3.5.1.13 and Section 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of northern rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI northern rockfish. The IPHC longline fishery has been identified as a non-contributing factor to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the northern rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI northern rockfish stock. The actual effect of climate changes and regime shifts on northern rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of northern rockfish prey species occurs in this fishery (see Section 3.5.1.13).

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI northern rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in northern rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on northern rockfish species habitat suitability, possibly having disrupted northern rockfish species spawning and/or rearing habitats (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the northern rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt northern rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the northern rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear

BSAI Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Shortraker and rougheye rockfish are currently managed under Tier 5.

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these stocks.

Fishing Mortality

The catch of BSAI shortraker/rougheye rockfish in 2003 was estimated as 900 mt. Projected catches from 2003-2008 are shown in Table H.4-16 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to decrease to 800 mt in 2005, then increase to 1,200 mt in 2006 and remain at this level through 2008. The 2003-2008 average catch is 1,000 mt. Under FMP 2.2, the projected catch of BSAI shortraker/rougheye rockfish in each year from 2003 to 2008 was estimated as 1,000 mt.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1,model projections indicate that the average harvest of 1,000 mt from 2003-2008 occurs largely in the central and western Aleutian Islands, with 500 and 300 mt harvested in each of these areas, respectively. The harvest of shortraker/rougheye rockfish in the central Aleutian Islands is taken largely in the Pacific ocean perch fishery, whereas the harvest in the western Aleutian Islands is taken in the Atka mackerel trawl fishery and the sablefish and Pacific cod longline fisheries.

Under FMP 2.2, model projections indicate that the average harvest of 1,000 mt from 2003-2008 occurs largely in the eastern and central Aleutian Islands, with 300 mt in each area. The harvest of shortraker/rougheye rockfish in the eastern Aleutian Islands is taken largely in the Pacific ocean perch trawl fishery, whereas the harvest in the central Aleutian Islands is taken largely in the Pacific cod longline fishery.

Status Determination

Under FMP 2.1, the ABC for shortraker/rougheye rockfish is set equal to the OFL. Under FMP 2.2, the catch rates are below the ABC and OFL values for all years. The MSST cannot be determined for these stocks

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. The sex ratio of BSAI shortraker/rougheye rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Shortraker/Rougheye Rockfish

Under FMP 2.1, the ABC for shortraker/rougheye rockfish is set equal to the OFL. An age-structured population model for is not available for either shortraker or rougheye rockfish, and projections of future OFL levels were made by carrying over the 2002 baseline values into the future. The projected TAC for shortraker/rougheye rockfish from 2003-2008 is equal to the OFL, and the mortality effects under FMP 2.1 are considered insignificant. Under FMP 2.2, BSAI shortraker/rougheye rockfish are fished at less than the ABC and the effect of mortality under FMP 2.2 is considered insignificant. Since the MSST is not able to be calculated, the spatial/temporal distribution of catch and other direct/indirect effects are unknown (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects of BSAI shortraker/rougheye rockfish are summarized in Table 4.5-24.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI shortraker/rougheye rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as a non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI shortraker/rougheye rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI shortraker/rougheye rockfish (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shortraker/rougheye rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of shortraker/rougheye rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery have been identified as non-contributing factors to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the shortraker/rougheye rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI shortraker/rougheye rockfish stock. The actual effect of climate changes and regime shifts on shortraker/rougheye rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of shortraker/rougheye rockfish prey species occurs in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to BSAI shortraker/rougheye prey availability since shrimp is on e of the main prey species of rougheye rockfish (see Section 3.5.1.13).

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI shortraker/rougheye rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in shortraker/rougheye rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on shortraker/rougheye rockfish species habitat suitability, possibly having disrupted shortraker/ rougheye rockfish species spawning and/or rearing habitats. The State of Alaska shrimp fishery is identified as a non-contributing factor to shortraker/rougheye rockfish habitat suitability since habitat degradation by shrimp fishery gear is not expected to occur (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the shortraker/rougheye rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt shortraker/rougheye rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the shortraker/rougheye rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

BSAI Other Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

The other rockfish assemblage falls under Tier 5.

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

Under FMP 2.1, the catch of Aleutian Islands other rockfish species in 2003 was estimated as 500 mt, increasing to 800 mt in 2004 before decreasing to 700 mt in 2008; the average catch from 2003-2008 was

700 mt. In the EBS, the projected harvest was 200 mt in 2003, decreasing to 100 mt in 2008; the average catch from 2003-2008 was projected at 100 mt. Under FMP 2.2., the catch of Aleutian Islands other rockfish in each year from 2003 to 2008 was 300 mt, and the projected harvest of EBS other rockfish was 100 mt in each of these years. Projected catches from 2003-2008 are shown in Tables H.4-1.13 and H.4-1.14 of Appendix H.

The 2003 OFL for this species complex is 846 mt and 1,280 mt in the Aleutian Islands and EBS, respectively (Reuter and Spencer 2002). Fishing mortality at projected levels under FMP 2.1 is below the OFL for other rockfish, so FMP 2.1 and FMP 2.2 are not likely to result in any significantly adverse impacts to these stocks.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1, in the Aleutian Islands, 78 percent of the average harvest of 700 mt occurs in the western Aleutian Islands, taken largely in the sablefish longline fishery and Pacific cod trawl fishery. In the EBS, the average catch of 100 mt is taken largely in the Greenland turbot and sablefish longline fisheries and the flathead sole trawl fishery. Information is insufficient to determine whether existing harvest patterns would undergo any significant change under FMP 2.1.

Under FMP 2.2, in the Aleutian Islands, 85 percent of the average harvest of 300 mt occurs in the cental and western Aleutian Islands, taken largely in the Atka mackerel and Pacific cod trawl fisheries and the Pacific cod and sablefish longline fisheries. In the EBS, the average catch of 100 mt is taken largely in the Pacific cod and Greenland turbot bottom trawl fisheries and the sablefish and Greenland turbot longline fisheries. Information is insufficient to determine whether existing harvest patterns would undergo any significant change under FMP 2.2.

Status Determination

The ABC and is set equal to the OFL for this species complex under FMP 2.1. Under FMP 2.2, the fishing the ABC and is set below the OFL value. The fishing mortality rates under both FMPs are below the OFL. The MSST cannot be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. Estimated sex ratios are not available for these species.

Habitat Suitability

Any habitat suitability impacts of FMP 2.1, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify at the present time due to insufficient data However, there is the potential for degradation of benthic habitats important to other rockfish species as a result of increased fishing for groundfish. Actions illustrated by FMP 2.1 include the repeal of all current closed areas except for those required to protect Steller sea lions. Areas now opened to groundfish fishing may result in either an increase in Other rockfish catch, or decreases depending on rockfish abundance and location of rockfish habitat. Information is insufficient to conclude at this time whether existing habitat conditions would undergo any significant change under FMP 2.1.

FMP 2.2 would retain existing closures and bycatch restrictions, so the extent that these measures protect habitat, these benefits would continue to accrue to other rockfish stocks. However, information is insufficient to conclude whether existing habitat conditions would undergo any significant change under FMP 2.2.

Prey Availability

As with habitat related impacts, any effects of FMP 2.1 or FMP 2.2 on predator-prey relationships would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Other Rockfish

Under FMP 2.1, the ABC for the other rockfish category is set equal to the OFL. An age-structured population model for is not available for either Aleutian Islands or EBS other rockfish, and projections of future OFL levels were made by carrying over the 2002 baseline values into the future. The projected TAC for other rockfish from 2003-2008 is below the OFL, and the direct and indirect effects under FMP 2.1 are considered either insignificant or unknown. The spatial/temporal distribution of catch should have no significant direct impact on stock productivity. There could be adverse effects on rockfish habitat depending on where fishing effort is directed in response to increased TACs, but there currently is insufficient information to determine the significance of these effects.

Under FMP 2.2, other rockfish are fished at less than the ABC and well below current OFL. As a result, the direct and indirect effects under FMP 2.2 are considered either insignificant or unknown. The spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects on BSAI other rockfish are summarized in Table 4.5-25.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those indicated for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other rockfish and is rated as insignificant. Fishing mortality at projected levels is below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those indicated for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI other rockfish catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of other rockfish are the same as those indicted for the BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in prey availability are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in habitat suitability are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is not possible to be determined. It is unknown whether the combined effect will make the other rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear, thus the combined effects are found to be significant.

GOA Northern Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

GOA northern rockfish is currently managed under Tier 3.

Total and Spawning Biomass and Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management. An important measure in this bookend that would impact all target species is that ABC would be set equal to overfishing. This would eliminate the buffer between ABC and overfishing that exists in FMP 1. Another measure in FMP 2.1 that could impact GOA northern rockfish is that the eastern GOA trawl closure in FMP 1 would be repealed. Both of these measures in combination would likely result in a larger catch of GOA northern rockfish than has been the case in years past, and increase the risk of overfishing. However, the projection model results for this bookend indicate a decrease in GOA northern rockfish catch instead of an increase. Therefore the projection results do not appear to be reasonable. Average fishing mortality during the years 2003 - 2008 is still expected to be less than or equal to F_{OFL} (0.066) (Table H.4-35 of Appendix H).

According to the description of FMP 2.2, this FMP is much less aggressive in its approach than FMP 2.1. The two particular measures that affected GOA northern rockfish catch in FMP 2.1 (setting ABC equal to overfishing and removing the eastern GOA trawl closures) are not part of FMP 2.2, so catch of GOA northern rockfish in FMP 2.2 should be reduced relative to FMP 2.1 and result in catches similar to those of FMP 1. Instead, the bycatch model results for FMP 2.2 show lower catch for GOA northern rockfish which may be unreasonable. However, average fishing mortality during the years 2003 - 2008 is still expected to be less than F_{OFL} (0.066) (Table H.4-35 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effect of FMP 2.1 on the spatial/temporal concentration of northern rockfish catch is similar to what the baseline situation has been in past years. The inclusion of the eastern GOA as an open trawl zone under FMP 2.1 would not be a major difference relative to the baseline for northern rockfish. Northern rockfish generally do not occur in the eastern GOA and the trawl inclusion in this area would not affect the spatial concentration of fishing. Fishing effort would continue to be compressed into a relatively short open season resulting in an increase risk of possible overfishing. The potential for localized depletion of the stock would also increase under the higher fishing mortality rates if fishing occurs year after year on localized aggregations of northern rockfish.

FMP 2.2 would have similar effects on the spatial/temporal concentration of northern rockfish catch as the baseline fishing. The inclusion of the eastern GOA no-trawl zone is consistent with the baseline situation. ABCs are geographically apportioned among management areas which provides some protection against localized depletion. The northern rockfish fishery would likely be concentrated into a relatively short open season, thereby increasing the risk of possible overfishing because of the difficulty of managing a short, compressed fishery. Under FMP 2.2, the potential for localized depletion of the stock exists if fishing occurs year after year on localized aggregations of northern rockfish.

Status Determination

Under FMP 2.1 and FMP 2.2, the projected B2003 of 42,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B2005 of 40,300 mt under FMP 2.1, and of 40,200 mt under FMP 2.2, is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition and Sex Ratio

Under FMP 2.1 and FMP 2.2, the age composition of GOA northern rockfish may be affected by fishing mortality as in FMP 1. No information is available to suggest that sex ratio would change under FMP 2.1 or FMP 2.2, but size composition of GOA northern rockfish might change in proportion to the change in age composition.

Habitat Suitability

Under FMP 2.1 and FMP 2.2, increased damage to epifauna by increased bottom trawl effort may adversely impact juvenile northern rockfish habitat. Bottom trawling or other fishing gear in contact with the ocean floor on the Gulf of Alaska continental shelf or upper slope could adversely impact juvenile northern rockfish habitat. Juvenile northern rockfish tend to live inshore in shallower depths than adults which are captured primarily between 75 - 175m. Juvenile northern rockfish may also be associated with epifauna that provides structural relief such as corals or sponges. If so, damage to this epifauna by bottom trawls may reduce survival of juvenile fish. However, there is insufficient information to conclude that habitat would undergo significant qualitative changes under FMP 2.1 or FMP 2.2.

Prey Availability

The major prey of northern rockfish is euphausiids, and northern rockfish may in turn be preyed upon by large piscivorous fish. There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Northern Rockfish

Under FMP 2.1 and FMP 2.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 2.1 and FMP 2.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA northern rockfish are summarized in Table 4.5-26.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries is identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to northern rockfish mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA northern rockfish and is rated as insignificant. Northern rockfish are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA northern rockfish stock is expected to be insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries is identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to northern rockfish change in biomass levels as a function of change in reproductive success (see below).

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the northern rockfish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.24) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management and is not expected to contribute to changes in genetic structure or reproductive success of northern rockfish. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. The magnitude and direction of the change in reproductive success with water temperatures is currently unknown. Climate changes and regime shifts are not considered to be contributors to change in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have an insignificant effect on northern rockfish prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on northern rockfish prey species (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since northern rockfish prey species bycatch is not expected to occur. Climate changes and regime shifts are identified as making potential beneficial or adverse contributions on prey availability, although the magnitude and the direction of change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the northern rockfish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 2.1and FMP 2.2 would have an insignificant effect on northern rockfish habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA northern rockfish stocks include past foreign, JV, and domestic fisheries, IPHC longline fishery and climate changes and regime shifts (see Section 3.5.1.24). Intense bottom trawling on northern rockfish habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries have also been identified as having adverse effects on northern rockfish habitat, although these effects are not expected to have been as intense as those effects associated with trawl gear see Section 3.6 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both beneficial and adverse effects on northern rockfish habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has been identified as an adverse contributing factor since the fishery gear could disrupt spawning and/or rearing habitats. Although, as state above, the impacts associated with longline gear are not as significant as those associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the GOA northern rockfish stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the northern rockfish stock to sustain itself at or above MSST is jeopardized.

GOA Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

GOA shortraker/rougheye are currently managed under Tier 4 and Tier 5. Direct/indirect effects are summarized in Table 4.6-1.

Total and Spawning Biomass

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter.

Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management than what is currently used by the NPFMC. An important measure in this bookend that would affect all target species is that ABC would be set equal to overfishing, which would eliminate the buffer between ABC and overfishing that exists in the baseline situation and FMP 1. Another measure in FMP 2.1 that would particularly impact shortraker/rougheye is that the eastern GOA trawl closure in FMP 1 would be repealed. Both of these measures in combination would likely result in a larger catch of shortraker/rougheye than has been the case in years past, and increase the risk of overfishing these stocks. The bycatch model results for this bookend; however, indicate catches approximately equal to those in past years, and therefore do not appear to be reasonable (Table H.4-34 of Appendix H).

FMP 2.2 is much less aggressive in its approach than FMP 2.1. The two particular measures that affected shortraker/rougheye catch in FMP 2.1 are not part of FMP 2.2, so one would expect that catch and ABC projections for shortraker/rougheye in FMP 2.2 should be nearly identical to those for FMP 1. Indeed, the ABCs for shortraker/rougheye in FMP 2.2 are the same as those in FMP 1, but the projected catches in FMP 2.2 are inexplicably higher than in FMP 1. Therefore, the catch results for shortraker/rougheye in FMP 2.2 do not seem reasonable (Table H.4-34 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 would have major effects on the spatial/temporal concentration of shortraker/rougheye catch compared to the baseline situation in past years. Because the eastern GOA trawl closure would be repealed in FMP 2.1, shortraker/rougheye would almost certainly be taken by bottom trawl again in this region. ABCs; however, would be geographically apportioned between management areas, which would continue to provide some protection against localized depletion of the resource. Because IFQs and fishing cooperatives are not part of this bookend, the trawl fisheries would likely continue to be concentrated into a relatively short open seasons. More importantly, the IFQ longline fisheries would be eliminated, and the longline fisheries would revert back to very compressed "derby" fisheries. This would increase the risk of overfishing shortraker/rougheye because of the difficulty managing these very short, intense fisheries.

FMP 2.2 would have very similar effects on the spatial or temporal concentration of shortraker/rougheye catch as has been the case for the baseline situation in past years. ABCs would be geographically apportioned between management areas, which would continue to provide some protection against localized depletion of the resource. Because IFQs or fishing cooperatives for trawl fisheries are not part of this bookend, any bycatch of shortraker/rougheye taken by trawl fisheries would likely continue to be concentrated into relatively short open seasons. Similar to the baseline, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery. In contrast, FMP 2.2 would retain the IFQ system for longline fisheries, which would reduce the risk of overfishing because IFQs allow the fisheries to be spread out over an eight month season.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL. Under FMP 2.2 the catch rates are below the ABC and OFL values for all years. The MSST cannot be determined for these stocks.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter. There is no information on the sex ratio of shortraker/rougheye, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 2.1 and FMP 2.2 is unknown.

Habitat Suitability

The main impacts of FMP 2.1 on habitat suitability of shortraker/rougheye would be caused by 1) increased bottom trawl activity because the bookend would increase ABCs and catches for all species, and 2) the bookend's repeal of the eastern GOA trawl closure. Increased bottom trawl activity would likely result in more damage to the benthic habitat, which could have a adverse impact on species such as shortraker and rougheye rockfish that have been observed living in association with epifauna such as corals.

Similar to FMP 1 and the baseline situation in past years, FMP 2.2 may impact habitat for shortraker/rougheye because it closes the eastern GOA to trawling. This closure prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of shortraker/rougheye, an undamaged benthic habitat may provide a benefit to these species. For example, observations from a manned submersible in the eastern GOA have found shortraker and/or rougheye rockfish associated with boulders along steep slopes (Krieger and Ito 1999) and with colonies of Primnoa coral (Krieger and Wing 2000). The eastern GOA trawl closure presumably causes a reduction in the alteration or destruction of these habitats, which may have a beneficial effect on shortraker/rougheye in this region.

Prey Availability

Pacific cod and to a lesser extent walleye pollock are species that are known to prey on shrimp, a major prey item of rougheye rockfish, so any changes in their abundance as a result of FMP 2.1 hypothetically could affect the food supply of shortraker/rougheye. Because FMP 2.1 sets ABC equal to the overfishing rate, catches of Pacific cod and walleye pollock would both increase substantially in the GOA, and their abundance would decrease. To protect Steller sea lions, FMP 2.2 has two measures that may reduce the catch and increase the abundance of Pacific cod and walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for two species. However, whether a change in abundance of Pacific cod or walleye pollock would actually affect the food supply for shortraker/rougheye is unknown, as there is no quantitative information on trophic interactions between all these species. Moreover, shortraker and rougheye rockfish reside in deeper depths than Pacific cod or walleye pollock, so they may not be competing for the same spatial aggregations of food.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA shortraker/rougheye rockfish are summarized in Table 4.5-27.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA shortraker/rougheye rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery and State of Alaska shrimp are identified as non-contributing factors to GOA slope rockfish biomass level since bycatch is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal concentration of catch under FMP 2.1 and FMP 2.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA shortraker/rougheye rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on shortraker/rougheye rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA shortraker/rougheye rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors to the change in genetic structure and reproductive success of GOA shortraker/rougheye rockfish since bycatch in these fisheries is unlikely to occur.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA shortraker/rougheye rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA shortraker/rougheye rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 2.1 and FMP 2.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on shortraker/rougheye rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery is identified as a non-contributing factor to shortraker/rougheye rockfish prey availability since bycatch of shortraker/rougheye rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since shrimp is a main prey item of rougheye rockfish.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA shortraker/rougheye rockfish; however, the effect is unknown due to lack of scientific information.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA shortraker/rougheye rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA shortraker/rougheye rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery has been identified as a potential adverse contributor to shortraker/rougheye rockfish habitat suitability due to impacts from fishery gear. The State of Alaska shrimp fishery is a non-contributing factor since habitat degradation from shrimp fishery gear is not expected to occur (see Section 3.6).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA shortraker/rougheye rockfish, the effect is currently unknown due to lack of scientific information.

GOA Slope Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Other slope rockfish are managed under Tier 5 and sharpchin rockfish are assessed under Tier 4. Direct/indirect effects are summarized under Table 4.6-1.

<u>Total and Spawning Biomass</u>

No projections are possible for these two parameters, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

<u>Fishing Mortality</u>

FMP 2.1 represents a less precautionary approach of fishery management than what is currently used by the NPFMC. An important measure in this bookend that would affect all target species is that ABC would be set equal to overfishing, which would eliminate the buffer between ABC and overfishing that exists in the baseline and FMP 1. An even more important measure in FMP 2.1 concerning slope rockfish is that eastern GOA trawl closure would be repealed. Because slope rockfish mostly reside in the eastern GOA and are predominantly caught by trawl, opening this region to trawling would make most of GOA population of slope rockfish vulnerable to fishing. Both of these measures in combination would result in a larger catch of slope rockfish than has been the case in years past, and increase the risk of overfishing slope rockfish stocks. The model results for this bookend indicate a modest increase in slope rockfish catch of about 300-400 mt

compared to the baseline and FMP 1 and recent past catches, but it is likely that if FMP 2.1 actually went into effect, catches of slope rockfish would show even more of an increase (Table H.4-31 of Appendix H).

FMP 2.2 is much less aggressive in its approach than FMP 2.1. The two particular measures that affected slope rockfish catch in FMP 2.1 (removing the eastern GOA trawl closures and setting ABC equal to overfishing) are not part of FMP 2.2, so one would expect that catch and ABC projections for slope rockfish in FMP 2.2 should be nearly identical to those for FMP 1. The model results for FMP 2.2; however, show ABCs for slope rockfish much less than for those FMP1, and the corresponding catch projections are inexplicably similar to FMP 2.1. Thus, ABC and catch results for slope rockfish in the model for FMP 2.2 do not appear reasonable (Table H.4-31 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 would have substantial effects on the spatial or temporal concentration of slope rockfish catch, especially because the eastern GOA trawl closure would be rescinded. This would allow trawling for rockfish species in the eastern GOA, where most of the GOA population of slope rockfish is located, and greatly increase the chance of localized depletion for some of the slope rockfish species. Because IFQs and fishing cooperatives are not part of this bookend, catches of slope rockfish would likely continue to be concentrated into relatively short open seasons when fishing for rockfish is allowed. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing slope rockfish species because of the difficulty of managing a short, compressed fishery.

FMP 2.2 would have very similar effects on the spatial or temporal concentration of slope rockfish catch as has been the case for the baseline situation in past years. There have been no studies to determine stock structure for any species of slope rockfish, and it is unknown if subpopulations exist. Consequently, there is a possibility that localized depletion may be occurring, despite the effort of geographic apportionment. However, because most of the biomass of slope rockfish occurs in the eastern GOA, which is closed to trawling in this FMP, localized depletion is unlikely under this FMP.

There are no measures in FMP 2.2 for IFQs or cooperatives for rockfish trawlers, who historically have taken most of the catch of slope rockfish in the form of bycatch. Because these measures do not exist in this FMP, it is likely that the rockfish trawl fishery would continue to be compressed into a short open season each year. This would cause a greater risk of possibly overfishing slope rockfish, because it is difficult to manage the fishery within this short time span.

Status Determination

No projections are possible for the fishing mortality rate or MSST, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. There is no information on the sex ratio of slope rockfish, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 2.1 or FMP 2.2 is unknown.

Habitat Suitability

The main impacts of FMP 2.1 on habitat suitability of slope rockfish would be caused by 1) the bookend's repeal of the eastern GOA trawl closure, and 2) increased bottom trawl activity because the bookend would increase ABCs and catches for all species by setting ABC equal to overfishing. The removal of the eastern GOA trawl closure would permit bottom trawlers to catch slope rockfish in the eastern GOA, where most of the slope rockfish biomass is located, and this region would no longer serve as a *de facto* refugium for slope rockfish species. Increased bottom trawl activity would likely result in more damage to benthic habitats, and therefore could have a adverse impact on slope rockfish. The impact could be especially acute for juvenile slope rockfish, which may be particularly dependent on such epifauna.

Similar to FMP 1, FMP 2.2 greatly impacts habitat for slope rockfish because it closes the eastern GOA to trawling. This creates a *de facto* no-take zone or refugium for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species.

Prey Availability

No studies have been done in Alaska to determine the food habits for any of the slope rockfish species. Many of the abundant species, such as sharpchin, harlequin, and redstripe rockfish, are relatively small in size and may be plankton-feeders, but this is conjecture. There is also no documentation of predation on slope rockfish, although larger fishes such as Pacific halibut that are known to prey on other rockfish presumably also prey on slope rockfish. Because of this lack of information, the effect of FMP 2.1 and FMP 2.2 on predator-prey relationships for slope rockfish is unknown.

Cumulative Effects of FMP 2.1 FMP 2.2

Cumulative effects of GOA slope rockfish are summarized in Table 4.5-28.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries and State of Alaska groundfish fisheries have been identified as having had a adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of other slope rockfish. The State of Alaska groundfish fisheries is identified as a non-contributing factor since catch and bycatch of slope rockfish species is already accounted for by the domestic groundfish fishery management. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA other slope rockfish and is rated as insignificant. Fishing mortality at projected levels is equal to or below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the other slope rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.24 and 3.10). The State of Alaska groundfish fisheries are identified as non-contributing factors to GOA slope rockfish biomass level. Although catch and bycatch do occur in these fisheries, the removals are already accounted for by the domestic groundfish fishery management.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA other slope rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal concentration of catch under FMP 2.1and FMP 2.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA slope rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA slope rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The State of Alaska groundfish fishery is identified as a non-contributing factor to the change in genetic structure and reproductive success of GOA slope rockfish. Although catch and bycatch of slope rockfish species occurs in these fisheries, they are not expected to contribute to localized depletion such that it leads to a detectable reduction in genetic diversity or reproductive success. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA slope rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA slope rockfish complex.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The change in prey availability under FMP 2.1 and FMP 2.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on slope rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to slope rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to slope rockfish prey availability since bycatch of slope rockfish prey species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA slope rockfish; however, the effect is unknown due to lack of scientific information.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, State of Alaska groundfish fisheries and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA slope rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA slope rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to slope rockfish habitat suitability. The State of Alaska groundfish fishery and the IPHC longline fishery have been identified as potential adverse contributors to slope rockfish habitat suitability due to impacts from fishery gear (see Section 3.6).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA slope rockfish, the effect is currently unknown due to lack of scientific information (Table 4.5-28).

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Until recently, dusky rockfish fell under Tier 4, while yellowtail and widow rockfish were managed under Tier 5. As of 2004, dusky rockfish will be managed under Tier 3 and the rest of the pelagic rockfish species will continue under Tier 5 until more information becomes available. GOA dusky rockfish were modeled under the Tier 4 category for this analysis. Direct/indirect effects are summarized in Table 4.6-1.

Total and Spawning Biomass

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish.

Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management than what is currently used by the NPFMC. An important measure in this bookend that would affect all target species is that ABC would be set equal to overfishing, which would eliminate the buffer between ABC and overfishing that exists in the baseline situation and FMP 1. Another measure in FMP 2.1 that would particularly impact PSR is that the eastern GOA trawl closure in FMP 1 would be repealed. Both of these measures in combination would likely result in a larger catch of PSR than has been the case in years past, and increase the risk of overfishing PSR stocks. The model results for this bookend; however, indicate a decrease in PSR catch, instead of an increase, and therefore do not appear to be reasonable (Table H.4-32 of Appendix H).

According to the description of FMP 2.2, this FMP is much less aggressive in its approach than FMP 2.1. The two particular measures that affected PSR catch in FMP 2.1 (setting ABC equal to overfishing and removing the eastern GOA trawl closures) are not part of FMP 2.2, so one would expect that catch and ABC projections for PSR in FMP 2.2 should be nearly identical to those for FMP 1. Instead, the model results for FMP 2.2 show ABCs for PSR substantially less than for those FMP 1, and the corresponding catch projections are inexplicably similar to FMP 2.1. Thus, catch and ABC results for PSR in the model for FMP 2.2 appear highly unreasonable (Table H.4-32 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1and FMP 2.2 would have very similar effects on the spatial or temporal concentration of PSR catch as has been the case for the baseline situation in past years. ABCs would be geographically apportioned between management areas, which would continue to provide some protection against localized depletion of the resource. Because rockfish IFQs and fishing cooperatives are not part of these bookends, the PSR fishery would likely continue to be concentrated into a relatively short open season. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL. Under FMP 2.2, the catch rates are below the ABC and OFL values. The MSST cannot be determined at this time for these stocks.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish. There is no information on the sex ratio of PSR, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 2.1 or FMP 2.2 is unknown.

Habitat Suitability

The main impacts of FMP 2.1 on habitat suitability of PSR would be caused by 1) increased bottom trawl activity because the bookend would increase ABCs and catches for all species, and 2) the bookend's repeal of the eastern GOA trawl closure. Increased bottom trawl activity would likely result in more damage to the benthic habitat, which could have a adverse impact on PSR such as dusky rockfish that may live in association with epifauna such as corals or sponges. The impact could be especially acute for juvenile dusky rockfish, which may be particularly dependent on such epifauna. The removal of the eastern GOA trawl closure would permit bottom trawlers to catch PSR in the eastern GOA, and this region would no longer serve as a *de facto* refugium that could help to replenish PSR stocks in other areas of the GOA.

Similar to FMP 1 and the baseline situation in past years, FMP 2.2 impacts habitat for PSR because it closes the eastern GOA to trawling. This creates a *de facto* no-take zone or refugium for PSR in this area, as trawls are generally the only effective gear for capturing these species. Although biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA only contains about 10-15 percent of the Gulfwide biomass of dusky biomass, this is still large enough that it may provide enhanced protection to the dusky rockfish resource.

Prey Availability

The major prey of dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). Euphausiids are also the major prey of walleye pollock, which means dusky rockfish and walleye pollock may be competing for the same food resource. Thus, any measures in FMP 2.1 that affect the commercial catch of walleye pollock could have an subsequent indirect effect on dusky rockfish by increasing or decreasing the amount of euphausiids available to dusky rockfish. Because this bookend sets ABC equal to the overfishing rate, catches of walleye pollock would increase substantially in the GOA. This would decrease the abundance of walleye pollock, and hypothetically increase the number of euphausiids available for consumption by dusky rockfish. To protect Steller sea lions, FMP 2.2 (similar to FMP 1 and the baseline situation in past years) has two measures that may reduce catch of walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for walleye pollock. Hypothetically, these two measures could increase the abundance of walleye pollock, resulting in the consumption of more euphausiids and having an adverse effect on the food supply for dusky rockfish.

However, there is little or no quantitative information on trophic interactions between dusky rockfish and walleye pollock or data on whether they even feed on the same spatial aggregations of euphausiids. Therefore, the effects of FMP 2.1 and FMP 2.2 on GOA PSR is unknown through the change in prey availability.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for the GOA PSR complex are summarized in Table 4.5-29.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA PSR complex is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA PSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR mortality since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA PSR and is rated as insignificant. PSR are expected to be fished at or below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effects of FMP 2.1 and FMP 2.2 on the biomass level are unknown.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR biomass levels since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass; however, the effect is unknown since total and spawning biomass levels and MSST are currently unavailable.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The effects of the fisheries on the spatial/temporal characteristics of GOA PSR under FMP 2.1 and FMP 2.2 are unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA PSR; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR genetic structure and reproductive success since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA PSR complex is possible; however, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability under FMP 2.1 and FMP 2.2 is currently unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on PSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a potential adverse contributor to GOA PSR prey availability. The catch of shrimp in the shrimp fishery is expected to continue in the future. Marine pollution is identified as a potential adverse contributor to PSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA PSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability under FMP 2.1 and FMP 2.2 is currently unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries have been identified as having past persisting adverse effects on GOA PSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA PSR habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR habitat suitability since the gear associated with this fishery is not expected to cause a significant impact to the benthic habitat (see Sections 3.5.1.24 and 3.6). Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA PSR, the effect is currently unknown due to lack of scientific information.

GOA Demersal Shelf Rockfish – Direct/Indirect Effects of FMP 2.1

Demersal shelf rockfish are managed under Tier 4. Direct/indirect effects are summarized in Table 4.6-1.

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for demersal shelf rockfish species. However, due to the removal of DSR bycatch and halibut IFQ program under this FMP, it is likely that the biomass of DSR will likely tend toward levels that jeopardize the ability of the stock to sustain itself at or above current population levels. Therefore, the direct/indirect effects of FMP 2.1 are ranked as significantly adverse for change in biomass.

Fishing Mortality

The catch (fishing mortality) of DSR in the eastern GOA would reach and likely exceed the DSR OFL, or 540 mt under this example FMP. It is presumed that managers would continue to set TAC below its ABC level to prevent the directed catch and the bycatch of DSR in the halibut fishery to exceed the OFL. It is unknown whether a directed fishery for DSR would be permitted under FMP 2.1 since this management plan would permit the reopening of the eastern GOA to trawl fishing. Historically trawl fisheries in this area have targeted Pacific ocean perch and other pelagic rockfish species. Bycatch of DSR in a trawl fishery is likely but would be difficult to estimate in advance. Mortality approaching 540 mt would raise serious management concerns about the sustainability of the population to withstand such a high exploitation rate. Recent investigations on rockfish exploitation strategies on the west coast of the U.S. suggest that a lower F50 value may be more appropriate for long-lived rockfish stocks than the current F40 rate. (Ralston *et al.* 2002; Ralston (1998); and Dorn (2002). Increasing the mortality level to 540 mt is the equivalent to a F35 exploitation rate. Nearing or exceeding this level would be detrimental to DSR. We conclude that the projected catch of the FMP 2.1 scenario would result in a significantly adverse effect (Table H.4-33 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

In the eastern GOA, most of the DSR harvest is taken in the southeast Outside District with the remainder taken from the east Yakutat Districts (O'Connell *et al.* 2002). We would expect a similar geographic distribution of DSR catch under FMP 2.1. However, as described above, localized deception of DSR stocks could be occurring within these districts. Due to the uncertainty that such localized depletion is occurring on the Fairweather Grounds (or elsewhere), we conclude that management under FMP 2.1 would have a conditionally significant adverse effect on the current environmental condition of DSR stocks in the eastern GOA.

Status Determination

The MSST cannot be determined for this stock complex.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA demersal shelf rockfish species. The sex ratio of GOA demersal shelf rockfish species is unknown.

Habitat Suitability

Any habitat suitability impacts of FMP 2.1, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, under this example FMP, trawl fisheries would again be permitted to operate in the eastern GOA for the first time in years. Information is insufficient to conclude where these fisheries would occur and whether existing habitat-related impacts would undergo significant change under FMP 2.1. Due to the uncertainty about the intensity of these effects, we have concluded that FMP 2.1 would have a conditionally significant adverse effect on the current environmental condition of DSR habitat.

Prey Availability

Any predator-prey impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify due to inadequate data. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under FMP 2.1. Therefore, the effects of FMP 2.1 on GOA DSR through prey availability are unknown.

Summary of Effects of FMP 2.1 – GOA Demersal Shelf Rockfish

Under FMP 2.1, the ABC for DSR rockfish is set equal to the OFL. An age-structured population model is not used for DSR rockfish and projections of future OFL levels were made by carrying the 2002 baseline values into the future. The projected TAC for DSR rockfish from 2003-2008 will be set below the OFL to prevent overfishing when taking into account any unreported catch, or bycatch mortality. However, combining all estimates of direct mortality raises the risk of overfishing DSR, especially since this FMP would eliminate the DSR bycatch limits in the halibut fishery and authorize renewed trawl operations in the eastern GOA. The uncertainties of the location, magnitude, or bycatch of DSR species in these fisheries has led us to conclude that there would be significantly adverse effects of this FMP on DSR species. Similarly, conditionally significant adverse effects resulting from localized depletion and habitat degradation are possible.

Cumulative Effects of FMP 2.1

Cumulative effects for the DSR complex are summarized in Table 4.5-30.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is significantly adverse under FMP 2.1.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR mortality since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A significantly adverse cumulative effect is identified for mortality of GOA DSR. The elimination of the DSR bycatch limits in the halibut fishery and renewed fishery operations in the eastern GOA increase the risk of overfishing. The combined effect of internal removals and removals due to reasonably foreseeable external events is expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** It is determined the effect of the fisheries on change in biomass level under FMP 2.1 is significantly adverse.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR biomass levels since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A significantly adverse cumulative effect is identified for change in biomass. The elimination of the DSR bycatch limits in the IPHC fishery and the reopening of trawl operations in the eastern GOA could reduce biomass levels. The combined effects of internal and external removals is expected to jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA DSR are identified as conditionally significant adverse.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA DSR; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on DSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and IPHC longline fisheries have been identified as non-contributing factors to GOA DSR genetic structure and reproductive success. Catch/bycatch of these fisheries is already accounted for by the domestic groundfish management or is not expected to occur (as in the case of the State of Alaska herring and shrimp fisheries). Marine pollution is identified as a potential adverse contributor to GOA DSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** The concentration of fishing in the Fairweather Grounds and the reopening of the eastern GOA to trawl operations could have significantly adverse effects on the current environmental condition of DSR stocks in the eastern GOA. The combined effects of internal and external removals are likely to jeopardize the ability of the stock complex to maintain current population sizes, therefore a rating of conditionally significant adverse is assigned to change in genetic structure and reproductive success of GOA DSR.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability under FMP 2.1 is currently unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on DSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as potential adverse contributors to GOA DSR prey availability. Catch of herring in the herring fishery and the catch of shrimp in the shrimp fishery are expected to continue in the future. The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to GOA DSR prey availability since bycatch of DSR prey species in not expected to occur. Marine pollution is identified as a potential adverse contributor to DSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Due to the potential increase in fishing effort as a result of the removal of DSR bycatch limits and the halibut IFQ program, we have determined FMP 2.1 to have a conditionally significant adverse effect on DSR habitat suitability.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries and the IPHC longline fisheries have been identified as having past persisting adverse effects on GOA DSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA DSR habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as non-contributing factors to GOA DSR habitat suitability since the gear associated with these fisheries are not expected to cause a significant impact to the benthic habitat. The State of Alaska groundfish fisheries and the IPHC longline fisheries are identified as potential adverse contributors to DSR habitat suitability (see Sections 3.5.1.24 and 3.6). Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect is identified for change in habitat suitability of the GOA DSR. The reopening of the eastern GOA trawl operations in combination with external removals are likely to jeopardize the capacity of the GOA DSR complex to maintain current populations.

Direct/Indirect Effects of FMP 2.2

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for demersal shelf rockfish species. However, due to the removal of the DSR bycatch levels and the removal of the halibut IFQ, the increase in DSR mortality could significantly reduce the DSR biomass to a level at which the capacity of DSR species to maintain current population levels is jeopardized. Thus, FMP 2.2 is rated as conditionally significant adverse for change in biomass.

Fishing Mortality

The projected catch of DSR rockfish would likely be a little lower under this FMP than FMP 2.1. DSR ABC levels would be set below the OFL to prevent overfishing. While a reduced ABC, and in turn a reduced TAC for DSR species would reduce the risk of overfishing, the removal of bycatch limits in the halibut fishery and the addition of trawl fisheries permitted by this FMP would likely offset any benefits of reduced ABCs. As described for FMP 2.1, mortality of DSR species would likely increase above current levels. Mortality approaching 540 mt would raise serious management concerns about the sustainability of the population to withstand such the higher exploitation rate. Recent investigations on rockfish exploitation strategies suggest that a lower F50 value may be more appropriate for long-lived rockfish stocks than the current F40 rate. (Ralston 1998, 2002, and Dorn 2002). Increasing the mortality to 540 mt is the equivalent to a F35 exploitation rate. Nearing or exceeding this level would be detrimental to DSR. We conclude that the projected catch of the FMP 2.2 scenario would result in a significantly adverse effect on DSR species (Table H.4-33 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

In the eastern GOA, most of the DSR harvest is taken in the southeast Outside District with the remainder taken from the east Yakutat District (O'Connell *et al.* 2002). We would expect a similar geographic distribution of DSR catch under FMP 2.2. However, as described previously for FMP 2.1, localized deception of DSR stocks could be occurring within these districts. Due to the uncertainty that such localized depletion is occurring on the Fairweather Grounds (or elsewhere), we conclude that management under FMP 2.2 would have a conditionally significant adverse effect on the current environmental condition of DSR stocks in the eastern GOA.

Status Determination

The MSST cannot be determined for this stock complex.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA demersal shelf rockfish species. The sex ratio of GOA demersal shelf rockfish species is unknown.

Habitat Suitability

Any habitat suitability impacts of FMP 2.2, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify due to inadequate data. However, unlike FMP 2.1, the trawl closure currently in place for the eastern GOA would remain, thereby maintaining the current level of habitat protection from this gear type. Due to the uncertainty about the intensity of these effects, we have concluded that FMP 2.2 would have a conditionally significant adverse effect on the current environmental condition of DSR habitat.

Prey Availability

Any effects to predator-prey relationships of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify due to inadequate data. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under FMP 2.2.

Summary of Effects of FMP 2.2 – GOA Demersal Shelf Rockfish

Under FMP 2.2, the ABC for DSR rockfish is set less than the OFL. An age-structured population model is not used for DSR rockfish and projections of future OFL levels were made by carrying the 2002 baseline values into the future. The projected TAC for DSR rockfish from 2003-2008 will be set below the OFL to prevent overfishing when taking into account any unreported catch, or bycatch mortality. However, combining all estimates of direct mortality raises the risk of overfishing DSR, especially since this FMP eliminates bycatch limits in the halibut fishery and would authorize renewed trawl operations in the eastern GOA. The uncertainties of the location, magnitude, or bycatch of DSR species in these fisheries has led us to conclude that there would be conditionally significant adverse effects of this FMP on DSR species. The effects to predator-prey relationships are unknown .

Cumulative Effects of FMP 2.2

Cumulative effects for the GOA DSR complex are summarized in Table 4.5-30.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is significantly adverse under FMP 2.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A significantly adverse cumulative effect is identified for mortality of GOA DSR. The elimination of the DSR bycatch limits in the halibut fishery and increase of fishing effort in the eastern GOA increases the risk of overfishing. The combined effect of internal removals and removals due to reasonably foreseeable external events is expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** FMP 2.2 is rated as conditionally significant adverse for change in biomass levels.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect is identified for change in biomass. If DSR bycatch limits in the IPHC fishery are eliminated, the increase of fishing effort in the eastern GOA could reduce biomass levels. Under those conditions, he combined effects of internal and external removals could jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** FMP 2.2 is rated as conditionally significant adverse for the spatial/temporal characteristics of GOA DSR under FMP 2.2.

- **Persistent Past Effects.** Past effects on the change in reproductive success and genetic structure of the GOA DSR are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in reproductive success and genetic structure of the GOA DSR are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** The concentration of fishing in the Fairweather Grounds and the increased trawl operations in the eastern GOA could have conditionally significant adverse effects on the current environmental condition of DSR stocks in the eastern GOA. The combined effects of internal and external removals are likely to jeopardize the ability of the stock complex to maintain current population sizes, therefore a rating of conditionally significant adverse is assigned to change in genetic structure and reproductive success of GOA DSR.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability under FMP 2.2 is unknown.

- **Persistent Past Effects.** Past effects on the change in prey availability of the GOA DSR are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of the GOA DSR are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Due to the potential increase in fishing effort as a result of the removal of DSR bycatch limits and the halibut IFQ program, we have determined FMP 2.2 to have a conditionally significant adverse effect on DSR habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of the GOA DSR are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of the GOA DSR are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect is identified for change in habitat suitability of the GOA DSR. The increased trawling efforts in eastern GOA in combination with external removals are likely to jeopardize the capacity of the GOA DSR complex to maintain current populations.

4.6.2 Prohibited Species Alternative 2 Analysis

4.6.2.1 Pacific Halibut

Pacific halibut are managed by the International Pacific Halibut Commission (IPHC). Halibut bycatch in Federal groundfish fisheries is controlled by the use of PSC limits. IPHC provides for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery.

FMP 2.1 and FMP 2.2 – Direct/Indirect Effects

Direct and indirect effects for Pacific halibut include mortality along with changes in reproductive success and prey availability. These effects, which are associated with changes in catch, are considered insignificant because annual quota setting processes implemented by IPHC account for all removals of halibut including bycatch in other fisheries. Thus, if changes to the baseline condition of the stock occur, they are reflected in the quotas set for the directed fishery. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. Halibut are opportunistic predators with a wide range of prey species, and no significant change to prey structure is expected as a result of FMP 2.1 or 2.2. No evidence of fishery impact to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows.

Under FMP 2.1, halibut PSC caps would be removed. Halibut bycatch mortality in the BSAI and GOA combined would increase from the present 6,800 mt to 12,000-15,000 mt as a result of increases in TAC levels for target groundfish fisheries. Such a scenario would require that the IPHC make a corresponding reduction of 5,000-8,000 mt in halibut catches by the directed fishery, or 10-20 percent of the 2002 level. Thus, even with removal of bycatch restrictions, IPHC would limit total removals of halibut to a level that would protect the resource to avoid adverse impacts to stock status.

Under FMP 2.2, halibut PSC caps would be retained. As a result, there would be no increased halibut mortality above current levels, and no adjustment to the halibut harvest quota by IPHC would be necessary.

FMP 2.1 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 2.1 is shown in Table 4.5-31, and a summary of the ratings for all effects is provided in Table 4.6-2. For further information on persistent past effects included in this analysis see Section 3.5.2.1 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 2.1 because current management of halibut by IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 2.1. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 2.1.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut, since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 2.1. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of FMP 2.1.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1.

FMP 2.2 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 2.2 is shown in Table 4.5-31, and a summary of the ratings for all effects is provided in Table 4.6-2. For further information on persistent past effects included in this analysis see Section 3.5.2.1.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 2.2 because current management of halibut by IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 2.2. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 2.2.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut, since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 2.2. No significant change to prey structure is expected as a result of FMP 2.2.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.2.

4.6.2.2 Pacific Salmon or Steelhead Trout

Pacific salmon are managed by the ADF&G, which also manages the salmon sport fisheries and permitted subsistence harvesting, to ensure that escapement goals are met for the spawning population in order to maintain sustained yields from the stock as a whole. Annual harvest levels are responsive to fluctuations in run sizes. Section 4.5.2.2 provides a detailed summary of current harvest rates and stock status for salmon in Alaska.

ESA-listed Pacific Northwest chinook salmon and steelhead trout were not specifically considered in this cumulative effects analysis as discussed in Section 4.5.2.2, which also presents a summary of assumptions included in the impact analysis of the FMPs.

The cumulative effects analyses were based on two groupings of Alaska salmon in BSAI and GOA: chinook salmon and other salmon. Refer to Section 4.5.2.2 for a list of the assumptions used during the cumulative effects analysis.

FMP 2.1 and FMP 2.2 – Direct/Indirect Effects

Direct and indirect effects for chinook salmon and other salmon in BSAI and GOA include mortality along with changes in prey availability, genetic structure of population, and reproductive success.

<u>BSAI – Chinook Salmon</u>

Under FMP 2.1, chinook salmon bycatch in BSAI varies from approximately 89,000 fish in 2003 down to 51,000 fish in 2007. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 30,000 to 62,000 fish during the next six years. This harvest represents approximately 10 to 20 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Under FMP 2.1, chinook salmon bycatch would increase by 17,000 to 44,000 fish. These catch levels represent a significant increase in bycatch (>25 percent increase) and may be detectable in natal streams. This increase may impact subsistence harvests and escapement, especially in years of poor runs such as the year 2000. The bycatch levels predicted under FMP 2.1 could have conditionally significant adverse impacts on the sustainability of individual runs and on the stock as a whole. If combined with increased harvests in the GOA under FMP 2.1, the increased chinook salmon catch would be 25,000 to 50,000 fish for a total catch of 46,000 to 84,000 fish. Such catch levels would be detectable, likely impact subsistence and commercial harvest or escapement, and have a conditionally significant adverse impact on the sustainability of individual runs or the stock as a whole.

Under FMP 2.2, chinook salmon bycatch in the BSAI varies from approximately 38,000 fish in 2003 to 24,000 fish in 2006. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 14,000 to 27,000 fish during the next six years. This harvest represents approximately 4.7 to 9.0 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This level of bycatch represents an increase of 1,000 to 9,000 fish, which may be considered significant in some years (greater than [>]25 percent). However, considering this increase across all chinook salmon runs in western Alaska, it is not likely to be detectable in natal streams, nor would it impact subsistence or commercial fisheries and escapement. If combined with increased harvests in GOA, this increase in BSAI catch could adversely impact population sustainability, especially in years of poor runs such as those seen in 2000. Therefore, the effects of mortality on BSAI chinook under FMP 2.2 are considered conditionally significant adverse.

BSAI – Other Salmon

Under FMP 2.1, bycatch of other salmon in BSAI varies from approximately 153,000 fish in 2003 down to a low of 82,000 fish in 2006. Assuming 96 percent of other salmon bycatch is chum salmon and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 16,000 to 29,000 fish during the next six years. This harvest represents approximately 1.5 to 2.6 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. Chum salmon bycatch would increase by 5,000 to 16,000 fish. Such bycatch levels represent a significant increase in harvest (> 25 percent increase), but would likely not be detectable in natal streams and would have little or no effect on subsistence or commercial harvests and escapement. When considered across all chum salmon stocks in western Alaska, this level of bycatch is not likely to significantly impact sustainability of any particular run or the stock as a whole. However, if combined with increased harvests in the GOA under FMP 2.1, chum salmon catches would increase by 11,000 to 24,000 fish. Such an increase could adversely impact population sustainability, especially in years of poor runs such as those in 2000. Therefore, the effects of mortality on BSAI other salmon under FMP 2.1 are considered conditionally significant adverse.

Under FMP 2.2 bycatch of other salmon in the BSAI varies from approximately 108,000 fish in 2003 to a low of 68,000 fish in 2006. Assuming 96 percent of this other salmon bycatch may be chum salmon and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 13,000 to 21,000 fish during the next six years This harvest represents approximately 1.2 to 1.9 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This represents a moderate (10 to 25 percent) to significant (> 25 percent) increase in the bycatch of 2,000 to 9,000 western Alaska chum salmon. When spread across all chum salmon runs in western Alaska, such increases are not detectable in natal streams, would not significantly impact commercial or subsistence harvests or escapement. However, such an increase could have adverse impacts to population sustainability, especially in years of poor runs such as those seen in 2000. Therefore, the effects of mortality on BSAI other salmon under FMP 2.2 are considered conditionally significant adverse.

GOA – Chinook Salmon

Under FMP 2.1, chinook salmon bycatch in GOA varies from approximately 27,000 individuals in 2003 to 38,000 individuals in 2008. Assuming 58 percent of GOA chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 16,000 to 22,000 fish during the next six years. This harvest represents approximately 5.3 to 7.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Chinook salmon bycatch would increase by 6,000 to 8,000 fish. Such catch levels represent a significant increase in bycatch (>25 percent increase). When spread across all the chinook salmon runs of western Alaska, this level of bycatch is not expected to be detectable in natal streams, impact subsistence harvests and escapement, or significantly impact the sustainability of the stock as a whole. However, if combined with increased bycatch in the BSAI under FMP 2.1, the increased chinook salmon catch would be 25,000 to 50,000 fish for a total catch of 46,000 to 84,000 fish. Such catch levels would be detectable, likely impact subsistence and commercial harvest and escapement, and may have a conditionally significant adverse impact on the sustainability of individual runs or the stock as a whole.

Under FMP 2.2, chinook salmon bycatch in the GOA varies from approximately 11,000 fish in 2003 up to 23,000 fish in 2008. Assuming 58 percent of GOA chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 6,000 to 13,000 fish during the next six years. This harvest represents approximately 2 to 4 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Such levels of bycatch are not expected to have a significant impact on the sustainability of the stock. Considering this increase across all chinook salmon runs in western Alaska, it is not likely to be detectable in natal streams, nor would it impact subsistence or commercial fisheries and escapement. However, if combined with increased harvests in BSAI, this increase in GOA bycatch could adversely impact population sustainability, especially in years of poor runs such as those seen in 2000. Therefore, the effects on mortality of GOA chinook salmon under FMP 2.2 are considered conditionally significant adverse.

GOA – Other Salmon

Under FMP 2.1, bycatch of other salmon in the GOA varies from approximately 10,000 fish in 2003 to 13,000 fish in 2008. Assuming 56 percent of this other salmon bycatch is chum salmon, the bycatch could range from 6,000 to 7,000 fish during the next six years. The proportion of these fish from western Alaska is unknown. Assuming that all of these fish were from western Alaska, this harvest represents approximately 0.5 to 0.6 percent of the average western Alaska commercial and subsistence harvest of approximately 900,000 chum salmon from 1998 through 2000. In most cases, such bycatch levels represent a minor to moderate increase in harvest (10 to 25 percent), although in some cases, there may be significant increases in harvest (>25 percent). When considered across all chum salmon runs in western Alaska, such an increase would not be detectable in natal streams and would have no detectable effect on subsistence or commercial harvests and escapement. However, this increase in catch could have a conditionally significant adverse impact to population sustainability, if combined with increased bycatch in BSAI during years of poor runs such as those seen in 2000. Therefore, the effects of mortality on GOA other salmon under FMP 2.1 are considered conditionally significant adverse.

Under FMP 2.2, bycatch of other salmon in the GOA varies from approximately 4,000 fish in 2003 up to 9,000 fish in 2008. Assuming 56 percent of this other salmon bycatch is chum salmon, the bycatch could range from 2,000 to 5,000 fish during the next six years. The proportion of these fish from western Alaska is unknown. Assuming that all of these fish originate in western Alaska, this harvest represents approximately 0.2 to 0.5 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. When spread across all chum salmon runs in western Alaska, these bycatch levels are not detectable in natal streams, would have no detectable impact on subsistence or commercial catches and escapement, and are not expected to significantly impact sustainability of the stock. Therefore, the effects of mortality on GOA other salmon under FMP 2.2 are considered insignificant.

FMP 2.1 – Cumulative Effects Analysis

Summaries of the cumulative effects analysis for chinook and other salmon associated with FMP 2.1 is shown in Tables 4.5-32 and 4.5-33. A summary of the ratings for all effects is provided in Table 4.6-2. For further information on persistent past effects included in this analysis see Section 3.5.2.2.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered conditionally significant adverse based on the predicted increases in catch under FMP 2.1. Such increases in bycatch levels would be detectable, likely impact subsistence and commercial harvest and escapement, and may have a conditionally significant adverse impact on the sustainability of the already depressed individual runs or the stock as a whole.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the following years and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of BSAI and GOA chinook and other salmon populations. The magnitude of these effects cannot be determined. However, current stock status of salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. GOA non-western chinook and salmon stocks are considered stable, but state and commercial fisheries still exert effects on mortality. Similar to western Alaska stocks, the magnitude of these effects cannot be determined. State sport fisheries are not viewed as having significant impacts to salmon stocks in the GOA and are not considered contributing factors to mortality of salmon populations as a whole. Land management practices heavily influence the condition of watersheds used by spawning salmon but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook and other salmon resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 2.1. Combined bycatch potential in the BSAI and GOA fisheries under this FMP could impede successful recovery of depressed stocks. Even for the relatively stable GOA other salmon populations, such an increase in bycatch under FMP 2.1 would not be desirable, and is considered to have a conditionally significant adverse impact due to the uncertainty regarding loss of population sustainability.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 2.1 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, a relationship between state commercial, subsistence, and (in the GOA) sport fisheries bycatch of prey and salmon prey availability has not been defined and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State hatchery enhancement programs occur in GOA, but do not include prey species of salmon. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 2.1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 2.1 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, salmon bycatch composition has not been determined. Potential effects of state commercial and subsistence fisheries, along with sport fisheries in the GOA, on genetic structure of salmon populations are unknown. Land management practices and long-term climate changes and regime shifts are not considered contributing factors to changes in GOA salmon populations. In the GOA, state hatchery enhancement programs focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in the BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 2.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 2.1 on reproductive success for BSAI and GOA chinook and BSAI other salmon are considered conditionally significant adverse since stock status in this region is currently depressed and catch prediction under this FMP would increase significantly. For GOA other salmon stocks, the effects of FMP 2.1 are unknown.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska, it may be inferred that reproductive success has been impacted in certain populations. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may also play a role in the reproductive success of certain salmon populations. Non-western Alaska chinook and other salmon stocks in the GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of increased catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Non-western chinook and other salmon stocks in GOA are considered stable, so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of these stocks are considered insignificant. Degradation of watersheds used by spawning salmon resulting from poor land management practices could significantly impact the reproductive success of BSAI and GOA salmon stocks. Thus, these practices are considered potentially adverse contributors to possible changes in reproductive success of this population. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska, and are considered potentially beneficial to the reproductive success of salmon.

  Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook and BSAI other salmon stocks could be impacted. Thus, increased catch predicted under FMP 2.1 may remove spawning adults destined for spawning grounds, and potential combined effects from internal and external events are considered conditionally significant adverse to the reproductive success of BSAI and GOA chinook and BSAI other salmon. Although current stock status of GOA other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA other salmon stocks under FMP 2.1.

FMP 2.2 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 2.2 is shown in Tables 4.5-32 and 4.5-33. A summary of significance ratings for all effects is provided in Table 4.6-2. For further information on persistent past effects included in this analysis see Section 3.5.2.2.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI chinook and other salmon is considered conditionally significant adverse based on the predicted increases in catch under FMP 2.2. When spread across all chum salmon runs in western Alaska, such increases in bycatch are not detectable in natal streams, and would not significantly impact commercial or subsistence harvests or escapement. However, such an increase could have adverse impacts to population sustainability, especially in years of poor runs. Therefore, the FMP 2.2 is found to have a conditionally significant adverse effect on BSAI salmon mortality. The levels of bycatch predicted for GOA salmon are not expected to have a significant impact on the sustainability of the stock. Therefore, FMP 2.2 is found to have an insignificant effect on mortality of GOA salmon.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the following years and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of chinook and other salmon populations. The magnitude of these effects cannot be determined, however, current stock status of salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. The GOA other salmon stocks are considered stable, thus the predicted catch rates under

FMP 2.2 do not show potential for impacts on stock sustainability and are considered insignificant. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA and have a potentially beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI chinook and other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 2.2. Combined bycatch potential in the BSAI fisheries under this FMP could impede successful recovery of depressed stocks in BSAI and impact sustainability of the stock as a whole. Current stock status of salmon in GOA is considered stable and combined effects of mortality on chinook and other salmon in this region resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 2.2 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of salmon prey items and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, a relationship between state commercial, subsistence, and (in the GOA) sport fisheries bycatch of prey and salmon prey availability has not been defined and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State hatchery enhancement programs that occur in GOA do not include prey species of salmon. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in both the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 2.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 2.2 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, salmon bycatch composition has not been determined, so potential effects of state commercial, subsistence, and sport fisheries on genetic structure of salmon populations are unknown. Land management practices and long-term climate changes and regime shifts are not considered contributing factors to changes in GOA salmon populations. State hatchery enhancement programs focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 2.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 2.2 on reproductive success for BSAI chinook and other salmon are considered conditionally significant adverse since stock status in this region is currently depressed and catch prediction under this FMP would increase significantly. For GOA stocks, the effects of FMP 2.2 are unknown.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska it may be inferred that reproductive success has been impacted in certain populations of BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may also play a role in the reproductive success of certain salmon populations. Stocks in GOA are currently considered stable so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Alaska chinook and other salmon stocks in GOA are considered stable, so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of these stocks are considered insignificant. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of increased catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potentially adverse contribution to the population as a whole. Degradation of watersheds used by spawning salmon resulting from poor land management practices could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potentially adverse contributions to possible changes in reproductive success of this population. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska and are considered potentially beneficial to the reproductive success of salmon. Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI fisheries, the sustainability of BSAI chinook and other salmon stocks could be impacted. Thus, increased catch predicted under FMP 2.2 may remove spawning adults destined for spawning grounds and potential combined effects from internal and external events is considered conditionally significant adverse to the reproductive success of BSAI salmon. Although current stock status of GOA chinook and other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA stocks under FMP 2.2.

4.6.2.3 Pacific Herring

Pacific herring are managed by the ADF&G. Harvest policy and allocations among gear (user) groups is established by the Alaska Board of Fisheries. Annual harvest quotas are set by ADF&G under an exploitation rate harvest policy; herring exploitation rates are capped at a maximum level of 20 percent statewide. All directed herring fisheries occur in state waters and are managed by regulatory stocks.

A detailed discussion of the modeling approach used in this analysis is included in Section 4.5.2.3. Given the low herring bycatch levels that are predicted across all FMPs, bycatch removals would not be expected to have significantly different impacts on herring abundance estimates among FMPs.

FMP 2.1 and FMP 2.2 – Direct/Indirect Effects

Direct and indirect effects for Pacific herring include mortality, along with changes in reproductive success, prey availability, and habitat. These effects, which are associated with changes in catch, are considered insignificant for the following reasons: bycatch of herring in the groundfish fisheries is generally low, the fisheries do not target herring prey, and spatial/temporal overlap between the groundfish fisheries and herring habitat is minimal. In addition, annual quota setting processes implemented by ADF&G are responsive to fluctuations in herring biomass.

FMP 2.1 and FMP 2.2 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 2 is shown in Table 4.5-34. For further information on persistent past effects included in this analysis see Section 3.5.2.3 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA herring is insignificant under FMP 2.1 and FMP 2.2 because even with the opening of the Herring Savings Areas, current management of herring by ADF&G is responsive to fluctuations in herring biomass. The herring savings areas reduce herring bycatch potential by triggering closures in years when herring are abundant within fishing grounds. Although FMP 2.1 would remove the herring savings areas, it is presumed that the intensive harvest management currently in place with ADF&G would account for any increases in catch or respond accordingly to changes in biomass.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have impacted herring populations over the long-term. In addition, past federal groundfish fisheries bycatch combined with the directed state fisheries have exceeded the state's herring harvest policy in the past and may still exert lingering effects on current herring populations in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur, but are closely managed by the state (ADF&G). Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. State subsistence catch does not constitute a significant amount of catch compared to the directed fishery and is accounted for in ADF&G herring management plans. These fisheries are not considered contributing factors to changes in herring mortality. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring mortality, especially for those populations that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass and fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. Thus, although some persistent past effects may still be present on certain herring populations in the BSAI and GOA, the combined effects of mortality on Pacific herring resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1 and FMP 2.2.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under FMP 2.1 and FMP 2.2, due to the low amounts of estimated herring bycatch, and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in reproductive success occurs, it would most likely be reflected in corresponding changes to biomass, which are incorporated into ADF&G management plans of Pacific herring.

- **Persistent Past Effects.** As discussed in the analysis of cumulative effects on Pacific herring mortality, past federal groundfish fisheries bycatch combined with the directed state fisheries have exceeded the state's herring harvest policy in the past and may still exert lingering effects on current herring populations in the BSAI and GOA. Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. It has been found that this type of contamination exposure to adult and larval herring can result in many adverse effects such as: increased rates of egg mortality, larval deformities, and immune system deficiencies. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur but are closely managed by the state (ADF&G). Fishing quotas are based on variable exploitation rates that account for declines in stock. State subsistence fisheries catch are also accounted for in ADF&G herring management plans. Thus, these fisheries are not considered contributing factors to changes in herring reproductive success. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring reproductive success, especially for those populations that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific herring depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass, and fishing quotas are based on variable exploitation rates that account for declines in stock. Although certain herring populations in the GOA have been impacted by EVOS, the stock as a whole is considered recovering. Thus, some persistent past effects may still be present on certain herring populations in the BSAI and GOA, but the combined effects on Pacific herring reproductive success resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1 and FMP 2.2.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The potential effect of Federal groundfish fisheries on prey availability for BSAI and GOA herring is insignificant under FMP 2.1 and FMP 2.2, because groundfish fisheries do not target herring prey and if current management by ADF&G is responsive to fluctuations in herring biomass regardless of the cause associated with the change. Thus, if a change in prey availability did occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of herring have been identified.

- **Reasonably Foreseeable Future External Effects.** Pacific herring prey primarily on zooplankton which is not affected by state directed herring fisheries or state subsistence fisheries. Thus, these fisheries are not considered contributing factors to changes in prey availability for herring. Future acute and chronic marine pollution could occur, but effects on prey such as zooplankton are unknown. Long-term climate change and regime shifts could have impacts to many species that contribute to the prey structure of Pacific herring. The nature of these impacts depends on the direction of the climatic shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** Potential effects of future natural events, such as marine pollution and climatic shifts, on prey availability for Pacific herring are unknown for FMP 2.1 and FMP 2.2.

Change in Habitat

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under FMP 2.1 and FMP 2.2, because current management of herring by ADF&G is responsive to fluctuations in herring biomass and spatial/temporal overlap between the fisheries and herring habitat is minimal. However, if a change in important habitat were to occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring. In FMP 2.2, the herring savings areas would reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds. Despite the removal of these areas under FMP 2.1, it is presumed that any significant changes to biomass would be accounted for in the harvest management plans set forth by ADF&G.

- **Persistent Past Effects.** Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. The long-term effects of this event to herring habitat are unknown. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** No evidence of fishery impact on habitat of herring exists. Thus, fisheries are not considered contributing factors to changes in herring habitat at this time. Future acute and chronic marine pollution could occur and is considered potentially adverse to some herring habitat, especially those that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts are not expected to significantly change physical habitat of Pacific herring.

- **Cumulative Effects.** Potential impacts of future natural events, such as marine pollution and climatic shifts, in addition to lingering contamination from EVOS on certain habitat of herring in the GOA exist, but effects are not known for FMP 2.1 and FMP 2.2.

4.6.2.4 Crab

Alaska king, bairdi Tanner crab, and opilio Tanner crab (also called snow crab) fisheries are managed by the State of Alaska, with Federal oversight and following guidelines established in the BSAI king and Tanner crab FMP (NPFMC 1989). Section 4.5.2.4 contains further information on current stock status and management of crab in Alaska.

For the cumulative effects analysis, crab stocks in BSAI and GOA will be placed in the following groups: Bairdi Tanner, Opilio Tanner (only BSAI), Red king, Blue king, and Golden king. Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, GOA opilio Tanner crab is not included in this analysis.

Direct/Indirect Effects FMP 2.1 and FMP 2.2

Direct and indirect effects for all species of crab in BSAI and GOA include mortality along with changes in biomass, reproductive success, prey availability, and habitat. These effects may be attributed to fishing activities (both directed and undirected), but may also be linked to natural events such as long-term climatic change and decadal regime shifts. Significance of these effects is based on the likelihood that population-level changes will result from internal events within the groundfish fishery. An effect that is considered insignificant corresponds to a change that is not likely to result in population-level effects on crab or that lies within the range of natural variability for the species. Significance ratings for the individual direct and indirect effects are discussed in the following cumulative effects sections.

Cumulative Effects Analysis FMP 2.1

Summaries of the cumulative effects analyses associated with FMP 2.1 are shown in Tables 4.5-36 through 4.5-42. Table 4.6-2 provides a summary of the significance ratings for all effects on crab. For further information on persistent past effects included in this analysis see Section 3.5.2.4 of this Programmatic SEIS.

The foundation of the cumulative effects analysis is the baseline description for each species that includes population status and trends, if known, and the major human and natural influences that have affected the population in the past and that continue to the present.

For each species, the predicted direct and indirect effects of the groundfish fishery are then analyzed for their contribution to the overall impacts from all sources, including reasonably foreseeable future events resulting from human and natural events external to the fishery. The reasonably foreseeable future events include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are rated according to the same significance criteria as the direct/indirect effects of the fishery and are based on the potential for population-level effects.

<u>Mortality</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 2.1, predicted catch of these crab species increases significantly from the current baseline condition, although catch trends do fluctuate throughout the five-year period. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Increases in crab catch and bycatch by federal fisheries, in addition to removal of protection areas, trawl closures, and PSC limits proposed under this FMP, could significantly impact sustainability and recovery of these already depressed stocks. Thus, FMP 2.1 is rated as significantly adverse to bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI considering that no signs of recovery have been evident for these stocks to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are managed by ADF&G in cooperation with NOAA Fisheries. These fisheries are considered to have a potentially adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect but the population is currently considered depressed. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI still exist and stocks are considered depressed, and in some instances overfished, with no signs of recovery to date. Thus, these combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events, are considered significantly adverse to bairdi Tanner, opilio Tanner, red king, and blue king crab populations in BSAI under FMP 2.1.These effects could further impede the recovery of the population, although the driving factor(s) behind the BSAI crab stocks' lack of recovery have not been determined.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Under FMP 2.1, predicted catch rates of golden king crab in BSAI and GOA were combined with those for blue king crab. The BSAI predictions showed slight increases in catch over the next five years when compared to current catch rates. Model projections for GOA catch showed minor decreases in catch compared to current catch in this region. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of FMP 2.1 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown. Potential increases in crab bycatch and catch, in addition to removal of protection areas, trawl closures, and PSC limits proposed under FMP 2.1, could have significant impacts on the sustainability of these stocks. However, potential combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined due to lack of a current baseline condition.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Under FMP 2.1, predicted catch of bairdi Tanner, red king, and blue king crab in GOA showed large increases from current catch levels over the next five years. However, significance of these predicted changes in catch on mortality is unknown. Some stocks of bairdi Tanner crab in GOA show signs of possible recovery while others are still considered depressed. Under FMP 2.1, potential for catch increases and removal of protection areas and trawl closures are proposed. This could have conditionally significant adverse effects on these stocks should lack of recovery continue. GOA red king stocks are severely depressed according to ADF&G survey data and do not show signs of recovery. For the same reasons mentioned above for bairdi Tanner crab, FMP 2.1 is rated as significantly adverse to red king crab stocks. Blue king crab stock status in GOA has not been determined by ADF&G, but it is presumed that these stocks may also be depressed. However, the effects of FMP 2.1 on mortality of blue king crab populations in GOA are unknown, until a baseline condition can be established.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in bottom trawl fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of external fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 2.1. Under FMP 2.1, crab catch is expected to increase while protection areas and trawl closures are removed. These factors, in addition to potential effects of mortality on red king stocks in the GOA are considered significantly adverse due to the already severely depressed nature of these stocks, and the lack of recovery that has been observed.

<u>Change in Biomass</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Increases in crab bycatch by federal fisheries, in addition to removal of protection areas, trawl closures, and PSC limits proposed under this FMP, could significantly impact sustainability and recovery of these already depressed stocks. Thus, FMP 2.1 is rated as significantly adverse to bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI considering that no signs of recovery have been evident for these stocks to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fishing effects could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. These fisheries are considered to have a potentially adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Potential effects of climate change and regime shifts on biomass levels of crab in BSAI have not been determined and depend on the direction of change that occurs.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI still exist and stocks are considered depressed with no signs of recovery to date. Increases in crab bycatch, in addition to removal of protection areas, trawl closures, and PSC limits proposed under FMP 2.1, could significantly impact sustainability and recovery of these stocks. Thus, these combined effects, resulting from past events, direct catch, internal bycatch, and reasonably foreseeable future external events, are considered significantly adverse to changes in biomass and sustainability of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. These effects could further jeopardize the sustainability of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI under FMP 2.1, although the driving factor(s) behind the BSAI crab stocks' lack of recovery have not been determined.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 2.1 on changes to biomass cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. The potential effects of past fishing mortality on biomass of golden king crab stocks in BSAI and GOA cannot be determined because catch composition is unknown, and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA is unknown, and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Potential effects of long-term climate change and regime shifts on crab biomass levels have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown and biomass estimates have not been determined. Thus, potential effects on biomass of BSAI and GOA golden king crab stocks, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.1.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Some stocks of bairdi Tanner crab in GOA show signs of possible recovery while others are still considered depressed. Under FMP 2.1, potential for catch increases and removal of protection areas and trawl closures are proposed. This could have conditionally significant adverse effects on these stocks should lack of recovery continue. GOA red king stocks are severely depressed according to ADF&G survey data and do not show signs of recovery. For the same reasons mentioned above for bairdi Tanner crab, FMP 2.1 is rated as significantly adverse to red king crab stocks. Blue king crab stock status in GOA has not been determined by ADF&G, but it is presumed that these stocks may also be depressed. The effects of FMP 2.1 on biomass of blue king crab populations in GOA are unknown until a baseline condition can be established.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in bottom trawl fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Adverse effects of past fishing mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in GOA may still exist as recovery of depressed stocks has not occurred.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to be managed by ADF&G in cooperation with NOAA Fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Potential effects of long-term climate change and regime shifts on crab biomass levels have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential effects on biomass of bairdi Tanner and blue king crab in GOA, resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.1. Potential effects on biomass of red king crab in GOA, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events are considered significantly adverse due to the already severely depressed nature of these stocks, lack of signs for recovery, and potential for increases in catch and removal of protection areas under FMP 2.1.The combined effects could further impede the recovery of the population, although the driving factor(s) behind the red king crab stocks' lack of recovery have not been determined.

Change in Reproductive Success

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. Changes in reproductive success within BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between spawning-recruitment success and depressed stock status cannot be concluded at this time. Increases in crab bycatch by federal fisheries, in addition to removal of protection areas, trawl closures, and PSC limits proposed under this FMP, could significantly impact sustainability and recovery of these already depressed stocks. Therefore, the potential effects of FMP 2.1 on changes to reproductive success are considered conditionally significant adverse to these stocks.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Directed crab fishing seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. Increases in crab bycatch by federal fisheries, in addition to removal of protection areas, trawl closures, and PSC limits proposed under this FMP, could significantly impact sustainability and recovery of these already depressed stocks. A relationship between spawning-recruitment success and other factors impeding on reproductive potential to depressed stock status cannot be drawn at this time Thus, potential effects reproductive success, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events, are considered conditionally significant adverse under FMP 2.1.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 2.1 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events are unknown for FMP 2.1 until a baseline condition is defined. It should be noted that increased mortality resulting from removal of PSC limits, bycatch restrictions, protection areas, and trawl closures as proposed under this FMP, could significantly impact the reproductive success and sustainability of these stocks.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Changes in reproductive success within GOA crab populations may be an underlying factor in the depressed nature of these stocks. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Although, a direct causation between reproductive success and depressed stock status cannot be concluded at this time, the potential for catch increases and removal of protection areas and trawl closures proposed under FMP 2.1, could have conditionally significant adverse effects on these stocks should lack of recovery continue. Red king crab populations in GOA are at historic lows according to ADF&G survey information. For the same reasons mentioned above for bairdi Tanner crab, FMP 2.1 is rated as conditionally significant adverse to red king crab stocks. Blue king crab stock status in GOA has not been determined by ADF&G, but it is presumed that these stocks may also be depressed. The effects of FMP 2.1 on reproductive success of blue king crab populations in GOA are unknown until a baseline condition can be established.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date. Current stock status of GOA blue king crab has not been determined, so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods so these fisheries are not considered contributing factors to changes in reproductive success of these stocks. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the GOA may still exist, and some stocks are considered depressed with no signs of recovery to date. Under FMP 2.1, there is a potential for increases in fishing mortality and removal of protection areas. This could have conditionally significant adverse effects on these stocks should lack of recovery continue. Potential effects on reproductive success of bairdi Tanner and blue king crab in GOA, resulting from past events, direct catch, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.1 due to lack of current baseline condition. Potential effects on reproductive success of red king crab in GOA, resulting from past, present, and future events are considered conditionally significant adverse due to the already severely depressed nature of these stocks, lack of signs for recovery, and potential for increases in fishing mortality and removal of protection areas under FMP 2.1.

Change in Prey Availability

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and it is unclear if FMP 2.1 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 2.1 on changes in prey availability cannot be determined.

- **Persistent Past Effects.** Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past fisheries is minimal. Thus, past effects on crab prey structure and availability in BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and these fisheries are not considered contributing factors to changes in prey availability. Rebuilding plans currently in effect in BSAI do not address crab prey structure and availability and are not considered contributing factors to potential changes in prey availability. Long-term climate change and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the potential effects that these changes may have on crab populations throughout BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined and potential changes to prey structure, resulting from past, present, and future events, cannot be determined for all species of crab in BSAI and GOA.

Change in Habitat

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. However, a direct link between changes to habitat and the depressed stock status of these crab species in the BSAI cannot be concluded at this time. Numerous ADF&G management measures, rebuilding plans, trawl closures, and conservation areas have been implemented to address declining and overfished crab stocks in BSAI. Under FMP 2.1, removal of protection areas and trawl closures throughout BSAI could impede on the recovery of these stocks and significantly impact the sustainability of BSAI crab stock as a whole. Thus, FMP 2.1 is considered significantly adverse to changes in crab habitat.

- **Persistent Past Effects.** The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of trawling and using other types of fishing gear that interact with bottom habitat. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered potentially adverse factors to possible changes in crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time and offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed, and possible habitat-related effects have not been determined. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. Although some of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, these protection measures would be removed under FMP 2.1. Thus, potential combined effects on BSAI crab habitat, resulting from past, present, and future events, would be considered significantly adverse to sustainability of these stocks due to the proposed removal of protection areas and trawl closures under this FMP.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout BSAI and GOA. Potential effects of FMP 2.1 to crab habitat are unknown.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on essential habitat are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered potentially adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors.

- **Cumulative Effects.** It is unclear if persistent past effects on golden king crab habitat in the BSAI and GOA exist. Some GOA golden king crab stocks are considered depressed, although some of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation zones. These protection measures would be removed under FMP 2.1; however, it is uncertain how these measures would affect the BSAI and GOA golden king crab stocks due to the lack of a current baseline condition. Thus, potential combined effects on BSAI and GOA golden king crab habitat, resulting from past, present, and future events cannot be determined for FMP 2.1 without first establishing the overall population status of this species. However, it should be noted that removal of protection areas and trawl closures proposed under this FMP could significantly impact the sustainability of this stock if increases in mortality and changes to reproductive success result.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Red king crab stocks are severely depressed in GOA according to ADF&G survey data. Bairdi Tanner crab stocks in the GOA are currently considered depressed while blue king crab stock status is unknown, but presumed to be depressed based on limited survey data. Although, a relationship between changes to habitat and depressed stock status cannot be drawn at this time the removal of protection areas and trawl closures throughout the GOA as proposed under FMP 2.1, could impede the recovery of these stocks and significantly impact the sustainability of GOA crab stock as a whole. Thus, this FMP is considered significantly adverse to changes in crab habitat for the already depressed red king crab stocks in GOA, and conditionally significant adverse for GOA bairdi Tanner crab stocks. This FMP could result in significantly adverse impacts to blue king crab stocks in GOA, but it is difficult to determine how these stocks will react to potential changes in habitat until a baseline condition has been established.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered potentially adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist, and stocks are considered depressed with no signs of recovery to date. Thus, potential combined effects on GOA red king crab habitat, resulting from past, present, and future events are considered significantly adverse under FMP 2.1. Potential combined effects on GOA bairdi Tanner and blue king crab habitat cannot be determined for FMP 2.1 without first establishing the overall population status of this species. Removal of protection areas and trawl closures proposed under this FMP, could significantly impact the sustainability of these stocks if increases in mortality, and changes to reproductive success result and impede on recovery of currently depressed stocks.

Cumulative Effects Analysis FMP 2.2

Summaries of the cumulative effects analyses for crab associated with FMP 2.2 are shown in Tables 4.5-36 through 4.5-42. Table 4.6-2 provides a summary of significance ratings for all effects (direct, indirect, and cumulative). For further information on persistent past effects included in this analysis (see Section 3.5.2.4).

Mortality

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 2.2, predicted bycatch of these crab species are slightly higher than the 2002 bycatch estimates. Blue king and red king crab bycatch are predicted to be the highest under this FMP, largely due to the spatial changes in distribution of the yellowfin sole and rock sole trawl fisheries. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances overfished. Thus, FMP 2.2 is considered to have a conditionally significant adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI due to the predicted increase in bycatch, and because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch, and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered to have potential adverse effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. Thus, these combined effects of mortality resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events are considered conditionally significant adverse for FMP 2.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Under FMP 2.2, predicted catch of golden king crab in BSAI and GOA were combined with predictions for blue king crab. The BSAI predictions showed increases and decreases in catch over the next five years when compared to current catch rates. Model projections for GOA catch showed decreases in catch compared to current catch in this region. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of FMP 2.2 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown. Thus, potential combined effects of mortality resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Under FMP 2.2, predicted catch of bairdi Tanner, red king, and blue king crab in GOA showed increases and decreases from current baseline for the next five years. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status of bairdi Tanner and blue king crab. Thus, effects of FMP 2.2 on mortality of GOA bairdi Tanner, and blue king crab are unknown. GOA red king crab stocks are severely depressed according to ADF&G survey data and do not show signs of recovery. Although red king crab bycatch is predicted to be slightly below the 2002 level, the effects of mortality could further impede the ability of this stock to recover. Thus, effects of FMP 2.2 on mortality of GOA red king crab are considered conditionally significant adverse.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in bottom trawl fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential combined effects of mortality resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 2.2. Potential combined effects of mortality on red king stocks in the GOA are considered conditionally significant adverse due to the already severely depressed nature of these stocks and apparent lack of recovery.

<u>Change in Biomass</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances overfished. The predicted bycatch levels under FMP 2.2 are expected to be slightly higher than baseline estimates. The bycatch levels predicted for red and blue king crab are the highest under this FMP. Thus, FMP 2.2 is considered to have a conditionally significant adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered to have potential adverse effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, the population is currently considered depressed. Potential effects of long-term climate change and regime shifts on biomass levels have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI still exist and stocks are considered depressed with no signs of recovery to date. Thus, these combined effects resulting from past events, direct catch, internal bycatch, and reasonably foreseeable future external events are considered conditionally significant adverse to biomass and sustainability of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI for FMP 2.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 2.2 on changes to biomass cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. The potential effects of past fishing mortality on biomass of golden king crab stocks in BSAI and GOA cannot be determined because catch composition is unknown, and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur be managed by ADF&G in cooperation with NOAA

Fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA is unknown and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Potential effects of long-term climate change and regime shifts on biomass levels has not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown and biomass estimates have not been determined. Thus, potential effects on biomass of BSAI and GOA golden king crab stocks resulting from past events, direct catch, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 2.2 on biomass of this species is unknown. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Thus, potential effects of FMP 2.2 on biomass of GOA bairdi Tanner crab as a whole cannot be determined. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Considering the severely depressed state of this stock as a whole, FMP 2.2 could have conditionally significant adverse effects on the biomass of red king crab populations in GOA, since no signs of recovery have been observed to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Adverse effects of past fishing mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in GOA may still exist, as recovery of depressed stocks has not been determined.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Potential effects of long-term climate change and regime shifts on biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential effects on biomass of bairdi Tanner and blue king crab in GOA resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.2. Potential effects on biomass of red king crab in GOA resulting from past events, internal bycatch, and reasonably foreseeable future external events are considered conditionally significant adverse due to the already severely depressed nature of these stocks and apparent lack of recovery observed to date.

<u>Change in Reproductive Success</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances overfished. Changes in reproductive success within BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a relationship between reproductive success and depressed stock status has yet to be determined. Therefore, the potential effects of FMP 2.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist, as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. The current baseline condition for blue king and bairdi Tanner crab is unknown and a direct causation between red king crab reproductive success and depressed stock status cannot be concluded at this time. Therefore the potential effects on reproductive success resulting from past, present, and future events are unknown for all stocks under FMP 2.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 2.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Crab seasons are set as to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success resulting from past, present, and future events are unknown for FMP 2.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 2.2 on changes to reproductive success cannot be determined. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Changes in reproductive success within GOA crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between reproductive success and depressed stock status cannot be concluded at this time. Potential effects of FMP 2.2 on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in GOA.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting period so these fisheries are not considered contributing factors to changes in reproductive success of these stocks. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Although crab seasons are set to avoid mating and molting periods, persistent past effects on crab populations in the GOA may still exist, and some stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success resulting from past, present, and future events are unknown for FMP 2.2.

<u>Change in Prey Availability</u>

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and it is unclear if FMP 2.2 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 2.2 on changes in prey availability cannot be determined.

- **Persistent Past Effects.** Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past groundfish fisheries is minimal. Thus, past effects on crab prey structure and availability in BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Competition for prey species of crab resulting from fisheries' catch has not been shown and is not considered a contributing factor to changes in prey availability. Rebuilding plans currently in effect in BSAI do not address crab prey structure and availability and are not considered contributing factors to potential changes in prey availability. Long-term climate change and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the effects that these changes may have on crab populations throughout BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined and potential changes to prey structure, resulting from direct catch, bycatch, and other future events cannot be determined for all species of crab in BSAI and GOA for FMP 2.2.

Change in Habitat

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. However, a direct causation between habitat and depressed stock status cannot be concluded at this time. Numerous ADF&G management measures, rebuilding plans, trawl closures, and conservation areas have been implemented to address declining and overfished crab stocks in the BSAI. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks. Potential effects of FMP 2.2 on changes to habitat are considered insignificant.

- **Persistent Past Effects.** The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat areas, as a result of trawling and using other types of fishing gear that interact with bottom habitat. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. These fisheries are considered potentially adverse factors in changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing . These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time and offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed, and possible habitat-related effects have not been determined. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. Although some of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, potential effects on crab habitat resulting from past, present, and future events cannot be determined for FMP 2.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout BSAI and GOA. Potential effects of FMP 2.2 to crab habitat are unknown.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on essential habitat are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered potentially adverse factors in changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors.

- **Cumulative Effects.** It is unclear if persistent past effects on golden king crab habitat in the BSAI and GOA exist, and some GOA golden king crab stocks are considered depressed. Although some of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, potential effects on golden king crab habitat resulting from past, present, and future events cannot be determined for FMP 2.2 without first establishing the population status of this species.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Red king and bairdi Tanner stocks in the GOA are currently considered depressed. Blue king crab stock status is unknown, but presumed to be depressed based on limited survey data. Although a relationship between changes in habitat and depressed stock status has not been determined, numerous ADF&G management measures, rebuilding plans, trawl closures, and conservation areas have been implemented to address declining crab stocks in the GOA. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks. Therefore, the potential effects of FMP 2.2 on changes to habitat for bairdi Tanner, red king, and blue king crab stocks in GOA are considered insignificant.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist, as some of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur and are considered potentially adverse factors in changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist and stocks are considered depressed with no signs of recovery to date. Although some of the known habitat areas of GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, potential effects on GOA bairdi Tanner, red king, and blue king crab habitat, resulting from past, present, and future events, cannot be determined for FMP 2.2.

4.6.3 Other Species Alternative 2 Analysis

The other species category consists of the following species:

- Squid (order Teuthoidea).

- Sculpin (family Cottidae).

- Shark (*Somniosus pacificus, Squalus acanthias, Lamna ditropis*).

- Skate (genera *Bathyraja and Raja*).

- Octopi (*Octopus dofleini,Opistholeutis california,* and *Octopus leioderma*).

An aggregate TAC limits the catch of species in this category. Within the other species category, only shark are identified to the species level by fishery observers. Furthermore, accuracy of catch estimates depends on the level of coverage in each fishery. Estimates of observer coverage in the BSAI is 70-80 percent, whereas the GOA has only approximately 30 percent observer coverage. Coverage can also vary for certain target fisheries and vessel sizes (Gaichas 2002). Further description of this management is described in detail in Section 3.5.3.

Formal stock assessments for other species are not currently conducted in the BSAI and GOA and biomass estimates for the species included in this category are limited and often unreliable. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. There are numerous direct and indirect effects that may impact the current and future status of individual species within this group and/or this group as a whole. These effects are summarized in the section that follows.

Direct/Indirect Effects FMP 2.1 – Other Species

Direct and indirect effects for other species include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 2.1 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 2.1, total catch of BSAI squid and other species is predicted to increase by several thousand tons per year. Catch of GOA other species is predicted to triple. This is due to predicted increases in catches of the target species that other species are caught with. Most of this increase is predicted in the catch of sculpin in the BSAI and skate in the GOA. Catch projections for specific groups within BSAI and GOA other species are presented below.

Squid

In the BSAI, squid catch is predicted to double initially and then decrease to just above the current level over the five projection years, likely following trends in the pollock fishery. The 2003 catch exceeds the historical OFL set for squid based on Tier 6 criteria, and might result in additional management measures being applied relative to those modeled if these were actual catches and if the same OFL were set in the future. Squid catch is predicted to triple over the five-year projection period in the GOA, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so tripling may not cause different population impacts than current catch levels.

Sculpin

Catches of BSAI sculpin are predicted to double, increasing from the current level of 7,000 mt per year to 13,000-15,000 mt per year. While this seems substantial, the effects on any of the approximately 50 different species of sculpin in this group are unpredictable because the effects of current levels of catch are unknown and species composition is currently unknown as well.

GOA sculpin catch is predicted to double over the projection period, reaching approximately 1,000 mt.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of sleeper shark are predicted to double initially and then decrease to roughly current levels, as are catches of salmon shark and other shark. Dogfish catches, which are low in the BSAI under current management, are predicted to decrease and then increase to current levels during the five year projection period under FMP 2.1. As in the BSAI, shark catches in the GOA are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark. While all shark catch in the GOA is predicted to be relatively low, catches of other shark are predicted to increase by an order of magnitude. Catches of salmon shark are predicted to decrease slightly, and catches of sleeper shark and dogfish will increase relative to current levels.

Skate

Skate currently make up the largest portion of bycatch for the other species complex. The catch of BSAI skate is predicted to decrease by nearly 3,000 mt initially within the first three projection years, and return to current levels by the end of the modeled period. GOA Skate catch is predicted to more than double to over 4,300 mt; an increase which could warrant increased management attention.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the target species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined big and longnose skates in the central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at 200-300 mt per year. However, observed GOA octopus catch has been low historically, so potential increases may not cause different population impacts than current catch levels. The trace amounts of octopus catch reported in the GOA are predicted to increase over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 2, FMP 2.1 is shown in Table 4.5-43. Table 4.6-2 provides a summary of the significance ratings for all effects. For further information on persistent past effects included in this analysis see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under Alternative 2, FMP 2.1. The current baseline condition is unknown and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA other species are unknown under Alternative 2, FMP 2.1. The current baseline condition is unknown and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. This possible overexploitation could have impacts to reproductive success, if sex-ratios of these species are significantly altered, or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since the current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in BSAI and GOA are unknown under Alternative 2, FMP 2.1. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under Alternative 2, FMP 2.1. The current baseline condition is unknown and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries. Formal stock assessments are not conducted for other species, and most biomass estimates for BSAI and GOA other species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species is unknown under Alternative 2, FMP 2.1. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species also have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Direct/Indirect Effects FMP 2.2 – Other Species

Direct and indirect effects for Other species include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 2.2 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 2.2, total catch of BSAI squid and other species and GOA other species is predicted to increase by several thousand tons per year. This is due to predicted increases in catches of the target species that other species are caught with. Most of this increase is predicted in the catch of skate and sculpin in both areas. Catch projections for specific groups within BSAI and GOA other species are presented below.

<u>Squid</u>

In the BSAI, squid catch is predicted to nearly double and then decrease to just above the current level over the five projection years, likely following trends in the pollock fishery. Squid catch is predicted to slowly increase to double its current magnitude over the five year projection period in the GOA, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so doubling may not cause different population impacts than current catch levels.

<u>Sculpin</u>

Catches of BSAI sculpin are predicted to increase by about 1,000 mt relative to current catches. GOA sculpin catch is predicted to increase by 200 mt per year over the projection period.

<u>Shark</u>

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of all of these species are predicted to increase slightly and then decrease to close to current levels under FMP 2.2. As in the BSAI, shark catches are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark. While all shark catch in the GOA is predicted to be relatively low, catches of other shark are predicted to increase by an order of magnitude. Catches of Pacific sleeper shark and salmon shark are predicted to decrease slightly, and catches of dogfish will remain relatively similar to current levels.

Skate

The catch of BSAI skate is predicted to increase by nearly 2,000 mt to over 21,000 mt for all projection years. The increased catch of skates may reflect increased catches in both longline fisheries for Pacific cod and in bottom trawl fisheries for cod and flatfish. Skate catch in GOA is predicted to increase by about 1,000 mt, which is the same order of magnitude as current catches and may warrant increased management attention if it actually happened.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the target species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined big and longnose skates in the Central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at about 500 mt per year. The trace amounts of octopus catch reported in the GOA are predicted to decrease slightly over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 2, FMP 2.2 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis see Section 3.5.3.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under Alternative 2, FMP 2.2. The current baseline condition is unknown and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success of BSAI and GOA other species are unknown under Alternative 2, FMP 2.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in BSAI and GOA are unknown under Alternative 2, FMP 2.2. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under Alternative 2, FMP 2.2. The current baseline condition is unknown and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries. Formal stock assessments are not conducted for other species, and most biomass estimates for BSAI and GOA other species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

<u>Change in Habitat</u>

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species is unknown under Alternative 2, FMP 2.2. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species also have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

4.6.4 Forage Fish Alternative 2 Analysis

The BSAI and GOA FMPs were amended in 1998 to establish a forage species category to prevent the development of directed fisheries on these ecologically important non-target species. Forage fish are described in more detail in Section 3.5.4.

Direct/Indirect Effects of FMP 2.1 – BSAI and GOA Forage Fish

<u>Total Biomass</u>

Total biomass of BSAI and GOA forage fish is unknown at this time. Under FMP 2.1, the ban on a directed fishery on forage fish would be repealed. If an intensive, directed fishery for forage fish were developed, it is possible to envision an adverse impact on forage fish populations. On the large scale, due to economic and biological factors, it is unlikely that a fishery with enough intensity would be able to develop to reduce forage fish populations to below a sustainable level. However, it is possible that a local fishery could develop and create localized forage fish depletions that could place competitive strains on predator populations (seabirds, marine mammals, groundfish). Without the development of a forage fish fishery, the effect of FMP 2.1 on the total biomass of forage fish is thought to be insignificant.

Spawning Biomass

Spawning biomass of BSAI and GOA forage fish is unknown at this time. Under FMP 2.1, it is possible for a fishery to develop on forage fish. If a fishery were developed, the spawning biomass could decrease from their current levels due to increased fishing effort. However, unless the fishery was extremely intensive it would most likely not significantly affect the spawning biomass.

Catch/Fishing Mortality

Under FMP 2.1, the ban on a directed fishery on forage species would be lifted. It is impossible to predict how the fishery would react to this. Even with a lifting of the ban, due to economic reasons a fishery for forage species would not necessarily commence. Therefore, the model can only forecast incidental catch rates of forage fish.

Forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (> 90 percent most years) of the forage fish bycatch is made up of smelt species (Osmeridae) from the pollock fishery. In the BSAI region, model projections for FMP 2.1 indicate incidental catch of forage fish would increase considerably above the current level (Table H.4-22 in Appendix H). Over the next 5 years the pollock catch in the GOA is projected to grow rapidly under FMP 2.1 (Table H.4-41 in Appendix H). This increased pollock catch under this FMP is expected to lead to greater, yet still relatively low, incidental catches of forage fish.

Fishing mortality of BSAI and GOA forage fish is unknown at this time. Under FMP 2.1, an increase in forage fish bycatch, and hence fishing mortality, would be expected. If a directed fishery for forage fish developed under FMP 2.1, fishing mortality would increase.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It would be hypothetically possible for a directed fishery under FMP 2.1 to create localized depletions in forage fish creating competitive forces on other predator species (marine mammals, sea birds, groundfish). However, it is unknown if this type of fishery would develop for economic reasons.

Status Determination

The MSST of forage fish species is unknown at this time, but it is highly unlikely that management practices under FMP 2.1 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. It is unknown how FMP 2.1 would change the age and size composition of the forage fish species. The sex ratio of forage fish is currently assumed to be 50:50. There is no information available that would suggest this would change under FMP 2.1.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data, it would be extremely difficult to accurately assess the predator-prey impacts of FMP 2.1.

Summary of Effects of FMP 2.1 – BSAI and GOA Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative assessment of this FMP's effects on these measures can be described.

A directed fishery for forage fish is currently prohibited by Amendment 36 and 39 in the BSAI and GOA FMP. Under FMP 2.1 this ban would be lifted. Direct effects of FMP 2.1 would include incidental take of forage fish in other fisheries and any direct take from a fishery that may develop. It is impossible to predict how, or even if, a forage fish fishery would develop under FMP 2.1. Even with a lifting of the ban, due to economic reasons a fishery for forage species would not necessarily commence. Therefore, the model can only forecast incidental catch rates for forage fish.

The model is able to estimate future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA. The bulk of the smelt bycatch comes from the pollock fishery. Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP. Under FMP 2.1 the pollock TAC is set to a more aggressive level. Pollock catch, and hence forage fish bycatch, is forecast to increase appreciably in the BSAI (Table H.4-22 in Appendix H). In the GOA the catch of pollock is also modeled to increase considerably in the next 5 years. Assuming the bycatch rate of forage fish stays constant, a large increase in the total forage fish bycatch is predicted (Table H.4-41 in Appendix H). Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 2.1 is thought to be a relatively small fraction of the biomass, and unlikely to affect the abundance of the stock in either the BSAI or GOA.

As stated above, FMP 2.1 removes the ban on a directed forage fish fishery. If a fishery were to be developed, for biological and economic reasons the most likely forage species group to be exploited would be the smelts (Osmeridae). If an intensive, directed fishery for smelt was developed, it is possible to envision an adverse impact on forage fish populations. On the large scale, due to economic factors, it is unlikely that a fishery with enough intensity would be able to develop to reduce forage fish populations to below a sustainable level. However, it is possible that a fishery could create localized forage fish depletions that could place competitive stress on predator populations (seabirds, marine mammals, groundfish).

Indirect effects of FMP 2.1 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 2.1.

Cumulative Effects Analysis of FMP 2.1 – BSAI and GOA Forage Fish

Tables 4.5-44 and 4.5-45 summarize the cumulative effects associated with FMP 2.1.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 2.1.

- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on mortality are indicated due to potentially adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts are not considered to be contributing factors, since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of forage fish (see Sections 3.5.4 and 3.10). Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish mortality; however, the removal of these species is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The change in biomass level under FMP 2.1 is rated as unknown.

- **Persistent Past Effects** have not been identified for the change in biomass in the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on the change in biomass are indicated due to the potentially adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts have been identified as having potentially beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment (see Sections 3.5.4 and 3.10). The Alaska subsistence and personal use fisheries have been identified as a potentially adverse contributor to the change in biomass level of BSAI and GOA forage fish. Subsistence and personal use fisheries concentrate mostly on the smelt species; however, it is unlikely that these fisheries would have a population level effect.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 2.1, the effect of the spatial/temporal concentration of catch is unknown.

- **Persistent Past Effects** are not identified for the genetic structure of the BSAI and GOA forage fish. Climate changes and regime shifts are identified as influencing the reproductive success of BSAI and GOA forage fish. For example, some Osmeridae species have shown a decline in recruitment since the late 1970s, coinciding with the increase water temperature.

- **Reasonably Foreseeable Future External Effects** on the reproductive success of forage fish due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has been identified as a potentially adverse contributor, since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as having potentially adverse contributions to the genetic structure and reproductive success of BSAI and GOA forage species. As stated above, these fisheries mainly target smelt species. However, it is unlikely the removals in these fisheries would sufficiently large and localized, such that they would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** are identified for the change in prey availability of the BSAI and GOA forage fish stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** of the climate changes and regime shifts on the BSAI and GOA forage fish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse contributor, since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potentially adverse contributors to the prey availability of BSAI and GOA forage fish. However, the catch/bycatch of these species is expected to be minimal and unlikely to have a population level impact.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for BSAI and GOA forage fish include climate changes and regime shifts (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** of the climate changes and regime shifts on the BSAI and GOA forage fish stock are potentially beneficial or adverse. Marine pollution has also been identified as having a potentially adverse contribution, since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Alaska subsistence and personal use fisheries are identified as potentially adverse contributors to forage fish habitat suitability (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is identified for BSAI and GOA forage fish habitat suitability; however, this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

Direct/Indirect Effects of FMP 2.2 – BSAI and GOA Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The incidental catch rates predicted for FMP 2.2 is not expected to affect biomass.

Catch/Fishing Mortality

A directed fishery on forage species is prohibited by Amendment 36 and 39 in the BSAI and GOA FMPs. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (>90 percent most years) of the forage fish bycatch is made up of smelt species (Osmeridae) from the pollock fishery. In the BSAI region, model projections for FMP 2.2 indicate incidental catch of forage fish would increase considerably above the current level (Table H.4-22 in Appendix H). Over the next 5 years the pollock catch in the GOA is projected to grow rapidly under FMP 2.2 (Table H.4-41 in Appendix H). This increased pollock catch under this FMP is expected to lead to greater, yet still small, incidental catches of forage fish.

Fishing mortality of BSAI and GOA forage fish is unknown at this time. As described above, forage fish bycatch and hence fishing mortality would increase under FMP 2.2. Currently, fishing mortality of forage fish is thought to be small, and the predicted increase is thought to be trivial.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under FMP 2.2.

Status Determination

The MSST of forage fish species is unknown at this time, but it is unlikely that management practices under FMP 2.2 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. It is assumed that the age and size composition of forage fish would not change under FMP 2.2. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 2.2.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data, it would be extremely difficult to accurately assess the predator-prey impacts of FMP 2.2.

Summary of Effects of FMP 2.2 – BSAI and GOA Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative assessment of the FMPs effects on these measures can be described.

A directed fishery for forage fish is prohibited by Amendment 36 and 39 in the BSAI and GOA FMPs. Therefore, the only direct effect of FMP 2.2 is incidental take of forage fish in other fisheries.

The model is able to estimate future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA. The bulk of the smelt bycatch comes from the pollock fishery. Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP. Under FMP 2.2 the pollock TAC is set to a more aggressive level. Pollock catch, and hence forage fish bycatch, is projected to increase appreciably in the BSAI (Table H.4-22 in Appendix H). In the GOA the catch of pollock is modeled to increase considerably in the next 5 years (Table H.4-41 in Appendix H). Assuming the bycatch rate of forage fish stays constant, a significant increase in the total forage fish bycatch will result. Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 2.2 is thought to be a relatively small fraction of the biomass and unlikely to affect the abundance of the stock in the BSAI or GOA.

Indirect effects of FMP 2.2 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 2.2 (Tables 4.5-87 and 4.5-88).

Cumulative Effects Analysis of FMP 2.2 – BSAI and GOA Forage Fish

Tables 4.5-44 and 4.5-45 summarize the cumulative effects of FMP 2.2 on BSAI and GOA forage fish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 2.2.
- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI or GOA forage fish stock.
- **Reasonably Foreseeable Future External Effects** on mortality are the same as those indicated under FMP 2.1.
- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.
- **Persistent Past Effects** have not been identified for the change in biomass in the BSAI and GOA forage fish stock.
- **Reasonably Foreseeable Future External Effects** on the change in biomass are the same as those indicated under FMP 2.1.
- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 2.2 the effect of the spatial/temporal concentration of catch is unknown.
- **Persistent Past Effects** identified for the change in reproductive success and genetic structure of the BSAI and GOA forage fish are the same as those indicated under FMP 2.1.
- **Reasonably Foreseeable Future External Effects** identified for the change in reproductive success and genetic structure of the BSAI and GOA forage fish are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.2, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for the change in prey availability are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects** identified for the change in prey availability are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, however, this effect is unknown. Information on forage fish prey interactions is insufficient.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.2, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for the change in habitat suitability are the same as those described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects** identified for the change in habitat suitability are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for BSAI and GOA forage fish habitat suitability; however, this effect unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

4.6.5 Non-Specified Species Alternative 2 Analysis

Grenadiers have been chosen to illustrate potential effects to non-specified species because they are currently the major catch in the non-specified FMP category. Non-specified species is a huge and diverse category encompassing every species not listed in the current FMP as a target, prohibited, forage, or other species. Considering a single species group from this category, such as grenadier, cannot possibly represent the diverse effects to all species in the category. However, because information is lacking for nearly all of these groups, and they are caught in small or unknown amounts (due to a lack of reporting requirements in this category), only potential effects to grenadier are discussed.

Formal stock assessments are not conducted for grenadiers. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. Changes in bycatch of grenadiers were predicted based on modeled changes in target species catches and population trajectories (sablefish target fisheries have the most grenadier bycatch). While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact grenadier populations, or whether these impacts might be adverse, beneficial, or neutral.

Direct/Indirect Effects FMP 2.1 – Non-Specified Species

Direct and indirect effects for grenadier include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown. Information on stock status is lacking, but is needed in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 2.1 are relatively small, such that diverse alternatives may have similar (but unknown) effects on each stock.

Under FMP 2.1, catch of grenadiers in both the BSAI and GOA is predicted to increase. In the BSAI, catches are double the currently observed level for most projection years. In the GOA, catches increase from about 11,000 mt to over 18,000 mt, a level which might warrant management attention if it were actually observed. However, even this level of catch has unknown population impacts because we do not know the species composition of the catch or the life history of any grenadier species in Alaskan waters to assess whether there would be population impacts.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 2, FMP 2.1 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis see Section 3.5.5 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 2.1. The current baseline condition is unknown. Catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier, and all other species included in the non-specified category, in the BSAI and GOA, could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA, and mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadiers and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadiers, and other species with the non-specified complex, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.1.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success of BSAI and GOA grenadier, and presumably all other species within the non-specified complex, are unknown under FMP 2.1. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. This possible overexploitation could have impacts on reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts on the reproductive success of grenadiers (and other non-specified species) depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadiers, and all other members of the non-specified category, will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadiers, and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadiers and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.1.

<u>Change in Genetic Structure of Population</u>

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier, and other species within the non-specified complex, populations in BSAI and GOA are unknown under FMP 2.1. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex have not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited. However, stock status remains unknown. This possible overexploitation could have impacts on the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadiers, and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.1.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadiers is unknown under FMP 2.1. The current baseline condition is unknown for all members of the non-specified complex, and species-specific catch information is lacking since species identification does not occur in the fisheries. Formal stock assessments are not conducted and biomass estimates in the BSAI and GOA for grenadiers, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier, and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. The current non-management of grenadiers could mask declines in individual grenadier species, and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadiers, and all other members of the non-specified group, depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadiers, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.1.

Direct/Indirect Effects FMP 2.2 – Non-Specified Species

Direct and indirect effects for grenadier include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 2.2 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 2.2, catch of grenadiers in both the BSAI and GOA is predicted to remain within or slightly above the currently observed range. In both areas, grenadier catch is predicted to increase slightly initially and then decrease, following trends in the sablefish fishery.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 2, FMP 2.2 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis see Section 3.5.5 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 2.2. The current baseline condition is unknown. Catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA, and mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadiers and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex, as a whole are unknown. The combined effects of mortality on grenadiers, and other species with the non-specified complex, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier, and presumably all other species within the non-specified complex, are unknown under FMP 2.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of grenadiers (and other non-specified species) depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadiers, and all other members of the non-specified category, will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadiers, and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes on reproductive success of grenadiers and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier and other species within the non-specified complex populations in BSAI and GOA are unknown under

FMP 2.2. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. This possible overexploitation could have impacts on the genetic structure of the population, if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, their potential impacts on genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadiers, and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.2.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadiers is unknown under FMP 2.2. The current baseline condition is unknown for all members of the non-specified complex. Species-specific catch information is lacking, since species identification does not occur in the fisheries. Formal stock assessments are not conducted, and biomass estimates in the BSAI and GOA for grenadiers, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. The current non-management of grenadiers could mask declines in individual grenadier species, and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadiers, and all other members of the non-specified group, depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadiers, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.2.

4.6.6 Habitat Alternative 2 Analysis

Alternative 2 seeks to maximize biological and economic yield from the groundfish fisheries by adopting a more aggressive harvest policy for groundfish stocks. Since this policy would result in increased fishing effort, more disturbance to benthic habitat is expected.

Direct/Indirect Effects of FMP 2.1

In addition to having a more aggressive harvest policy, FMP 2.1 illustrates a scenario where the agency repeals the various closure areas currently in place, with the exception of those required to protect Steller sea lions. Figure 4.2-2 illustrates the year-round closures in the BSAI and GOA management areas. In this FMP scenario, the fishery would be returned to an open access regime, where closures, gear restrictions, and PSC limits are repealed.

Direct and indirect effects of the FMP on habitat are discussed under the topics of changes to living habitat through direct mortality or benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to differences in habitat type, the BSAI and GOA are rated and discussed separately.

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

In the GOA, based on the multi-species model, the catch of most living habitats is projected to increase under FMP 2.1 (Table 4.5-48). However, catch of coral in the GOA is projected to decrease. This decrease in the model projection for coral is due to a constraint in the aggregated rockfish fishery catch (Jim Ianelli, AFSC, personal communication). In the baseline, bycatch of corals is highest in the aggregated rockfish fishery. As with FMP 1, we believe a more realistic prediction is that bycatch levels under FMP 2.1 would be about the same or would increase due to increases in groundfish TACs relative to the baseline. In the BSAI, some bycatch levels of coral increased and others decreased in the model projections. A more realistic prediction under FMP 2.1 is that bycatch levels would be about the same or would perhaps increase relative to the baseline. Reliable abundance estimates are not available for most living substrates, and the level of abundance of living habitat species needed to sustain their functional role as habitat for groundfish is not known. Some of these organisms have life-history traits that make them especially sensitive to fishing removals. The long-lived nature of corals and perhaps some sponges, in particular, makes them susceptible to permanent eradication in fished areas. Continued bycatch and damage at increased levels in FMP 2.1 could have long-term negative consequences to habitat quality.

Conceptual deductions from the habitat impacts model yield the following inferences:

- **Bering Sea.** Whether opening up new areas to fishing will result in an increased mean impact level, E, depends on habitat sensitivity parameters q, q_H, and densities of target species and habitat. The model indicates that for lower values of q and q_H (longer recovery times) catch changes faster than the equilibrium impact level for a given change in effort than at higher (short habitat recovery time) values for these parameters. Lower values for sensitivity also result in a greater impact E for a given effort level. Therefore, if sensitivity values are low, opening new areas will likely result in an increase in mean impact level, and the impact will be high. For shorter recovery times, impacts will be less severe, while there is more chance of a decrease in mean impact level with the opening of new areas. A decrease in mean impact level is beneficial, and impact severity may not be high enough to be of concern. In the former case, higher mean impact levels in combination with more severe impacts will result in detrimental impacts of concern. In addition, increased TACs as projected for FMP 2.1 will lead to greater fishing effort, which would increase impact level. Based on these results, we conclude that there would be significantly adverse change in mortality and damage to living habitat as a result of FMP 2.1.

- **Aleutian Islands.** The same situation exists in the Aleutian Islands as described above for the Bering Sea. However, a detrimental scenario is more probable in this region due to a greater likelihood of slow recovering organisms impacted. Based on these results, we conclude that there would be significantly adverse change in mortality and damage to living habitat as a result of FMP 2.1.

- **GOA.** The situation in the GOA is intermediate to the situations in the Bering Sea and in the Aleutian Islands in regard to likelihood of detrimental impacts to slow recovering organisms. It is concluded that there would be significantly adverse change on mortality and damage to living habitat as a result of FMP 2.1.

<u>Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection</u>

- **Bering Sea.** Baseline closed areas are eliminated in example FMP 2.1. Table 4.5-49 shows that of the Bering Sea fishable area, 7.6 percent is closed to bottom trawling under FMP 2.1. Figure 4.6-1 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.6-2 depicts those areas closed to fixed gear only. The eliminated closure areas were adjacent to areas (e.g., historic cluster) of intermediate fishing intensity and, therefore, provided some diversity of impact in the habitat found along the boundary. They also protected crab, halibut, and other prohibited species habitat. Thus, the predicted effect of FMP 2.1 on benthic community diversity is significantly adverse relative to the existing baseline due to eliminating the closed areas. The effects of FMP 2.1 on geographic diversity of impacts are predicted to be conditionally significant adverse.

- **Aleutian Islands.** Under FMP 2.1, similar to the baseline, there are no significant notable marine reserves except for shallow areas near sea lion rookeries, which remain closed in this FMP. As shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutians is closed to bottom trawling at one time or another during the year under this FMP. Less than one percent of the deep area is closed to bottom trawling. Figures 4.6-1 and 4.6-2 show the closure areas under FMP 2.1 broken down by gear type, bottom trawl, and fixed gear. As seen on the figures, closure areas in the Aleutians are the same as those shown and discussed for FMP 1 and the baseline. As such, there is little diversity in protection. The Aleutian Islands bathymetry and habitat is distributed on a fine scale, with fishing effort that is patchy and in small clusters. Based on these observations as relative to the baseline, the predicted effects of FMP 2.1 on benthic community diversity are considered conditionally significantly adverse due to the predicted increase in concentrated fishing effort. The geographic diversity of impacts are considered insignificant due to the similarity in closed areas under the baseline condition.

- **GOA.** As shown on Table 4.5-49 and Figures 4.6-1 and 4.6-2, FMP 2.1 closes nearly 22 percent of the fishable area in the GOA to trawling at one time or another during the year. However, the FMP eliminates the baseline closed area that was adjacent to an area of intermediate fishing intensity, which provided some diversity of impact in habitat found along the boundary. Therefore, the predicted effect of FMP 2.1 on benthic community diversity is significantly adverse relative to the existing baseline due to the opening of these closed areas. The predicted effects of FMP 2.1 on geographic diversity of impacts is conditionally significant adverse, also due to the opening of these closed areas.

Cumulative Effects of FMP 2.1

Cumulative effects on habitat for FMP 2.1 are summarized on Table 4.5-50. The following discussion of cumulative effects as presented on the table is broken down by geographic area.

Bering Sea

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Mortality of species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts that include mortality due to smothering and reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use are possible at several locations in the Bering Sea area, including Port Moller, Port Heiden, Dillingham, St. Paul and St. George. Again, the impacts include mortality due to smothering and/or burying, would only affect nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable, potentially adverse effect since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Again, areas most likely to be impacted would be nearer to shore. Natural events such as storm surges and waves also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Cumulative effects on mortality of Bering Sea benthic organisms are judged to be significantly adverse under FMP 2.1. Additional external factors would not improve conditions and could add to the mortality of benthic organisms.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution all have the potential to cause changes to benthic community structure. If the effect is long-term, as in the case of changes in weather patterns, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed under changes to living habitat, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Nina events have been identified as having impacts on both the physical and biological systems in the North Pacific. These changes could have either beneficial or adverse effects on the benthic community (see Sections 3.6 and 3.10).

- **Cumulative Effects.** Cumulative effects on benthic community structure of the Bering Sea are judged to be significantly adverse under FMP 2.1. Additional external factors would not improve conditions, and could add to adverse changes in the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described previously in Section 4.6.6 this effect is judged to result in a conditionally significant adverse change from baseline conditions, and as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 illustrate the spatial measures that were in effect before 1980 or were later established by regulations following publication of the Final Groundfish SEIS in November of 1980. As discussed in Section 3.6, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to spatially and temporarily restrict the foreign fishery. This was done to prevent conflicts between domestic and foreign fisheries over bycatch of species important to U.S. fishermen or grounds preemption and gear conflicts. Most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that, in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion, and marine pollution all have the potential to change geographic diversity and impacts protection. As existing ports in the Bering Sea are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, the opening of new ports may allow vessels of all sizes to access new or relatively unfished areas. On the other hand, depending on distribution, fishing pressure in heavily fished areas may be eased as access to other areas becomes available. Closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects**. Cumulative effects on changes in distribution of fishing effort are judged to be conditionally significant adverse. The maps and statistics discussed under persistent past effects show that FMP 2.1 would protect slightly less benthic habitat from trawl gear in the future (7.6 percent) than was protected in 1980 (8.6 percent). This FMP opens many crab and halibut habitat protection areas that are presently closed. Additional external effects are not expected to improve the internal FMP rating.

Aleutian Islands

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutians. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. However, mobile epibenthic predators are not likely to exhibit lingering effects since they can move into non-fished areas (see Section 3.6). The areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering,with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Dredging for scallop fisheries and/or navigation can occur in localized areas (often in conjunction with port development) and can cause burial or smothering of benthic fauna. Damage to living substrates by longline and pot fisheries (see Section 3.6) has been documented and is expected to continue in those heavily fished areas. Offal discharge can occur from offshore catcher processors and onshore processors, causing mortality in nearshore areas. However, improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use is possible at several locations in the Aleutian Islands including Atkutan, Adak, Unalaska, Cold Bay Dutch Harbor, and King Cove. Again, the impacts include mortality due to smothering and/or burying, and would only affect nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable potentially adverse impact since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events, such as storm surges and waves, also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Cumulative effects on mortality of Aleutian Islands benthic organisms are judged to be significantly adverse. Additional external factors would not improve conditions, and could add to the mortality of benthic organisms.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above in previously in 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline and pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause changes to benthic communities. If the effects is long-term, as in the case of changes to weather patterns, wind induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed under changes to living habitat, all of these impacts are more likely to be observed in nearshore areas. Regime shifts and large-scale environmental fluctuations associated with ENSO and La Nina events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Cumulative effects on in benthic community structure of the Aleutians are judged to be significantly adverse. Additional external factors would not improve conditions, and could add to adverse changes in the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.6.6, this effect is judged to result in an insignificant change to the baseline, and as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed previously for the Bering Sea, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species; most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that, back in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries, in order to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 about 31 percent of the fishable area in the Aleutians was closed to trawling with about 6 percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future external effects include other fisheries, port expansion and the potential resultant changes to offal discharge, and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As with the Bering Sea, existing ports in the Aleutians will be expanded and new ports created, and additional dock space for harboring the fishing fleet will be made available. While the fleet might not necessarily expand, the distribution of fishing effort is likely to change, and previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged to be conditionally significant adverse. The maps and statistics discussed above under persistent past effects show that FMP 2.1 would protect more benthic habitat from trawl gear in the future (43 percent) than was protected in 1980 (31 percent). However, the spatial distribution of the closed areas under the current FMPs may not protect the full range of habitat types. Additional external impacts do not provide any protection and could add to lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 2.1 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished, and impacts would occur in areas not previously impacted.

GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As described for the BSAI, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Port expansion and increased use is possible at several locations in the GOA, including Kodiak, Sand Point, Chignik, Port Lions, Ouzinkie, Valdez, and Seward. Impacts include mortality due to smothering and/or burying, and would likely only affect nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable potentially adverse effect since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events, such as storm surges and waves, also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organism.

- **Cumulative Effects.** Cumulative effects on mortality of GOA benthic organisms are judged to be significantly adverse. The additional external factors would not improve conditions, and could add to the mortality of benthic organisms.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As with the other regions, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to GOA benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Cumulative effects on changes in benthic community structure of the GOA are judged to be significantly adverse. The additional external factors would not improve conditions, and could add to adverse changes in the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a conditionally significant adverse change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed for the other regions, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring, and there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries (Figures 3.6-6 and 3.6-7). Table 4.5-51 shows that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, with about 7 percent closed to all fishing. The largest closures in the GOA were for longline fishing, where almost 61 percent of the fishable area was closed to longlining. Therefore in 1980, about 73 percent of the fishable area in the GOA was closed to fishing of one type or another sometime during the year.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future external effects include other fisheries, port expansion and the potential resultant changes to offal discharge, and marine pollution. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As existing ports in the GOA are expanded and new ports created, additional dock space for harboring the fishing fleet is made available, and changes in the distribution of fishing effort could result. Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case. Closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged to be conditionally significant adverse. The maps and statistics discussed under persistent past effects show that FMP 2.1 would protect more benthic habitat from trawl gear in the future (22 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under FMP 2.1 may not protect the full range of habitat types and crab and halibut habitat protection areas that are presently closed would be opened under this scenario. Also, in 1980 more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under FMP 2.1 (<1 percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. Therefore, the additional past and external effects are not expected to improve the internal FMP rating.

Direct/Indirect Effects of FMP 2.2

Example FMP 2.2 is identical to FMP 1 for habitat impacts. Figure 4.2-3 (bookend) illustrates the suite of year-round closures in the BSAI and GOA management areas.

Direct and indirect effects of FMP 2.2 on habitat are discussed for changes to living habitat through direct mortality or benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to their differences in habitat type, the BSAI and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

In the GOA, the multi-species model results indicate that catch of most living habitats will decline under FMP 2.2. (Table 4.5-48). In the BSAI, bycatch levels are predicted to be within approximately 20 percent of the baseline. The model projections for the GOA are unrealistically low relative to the baseline. This is because the model framework artificially constrained specific fisheries, such as rockfish, that historically have had a high bycatch rate of living substrates (Jim Ianelli, AFSC, personal communication 2003). Based on past performance, it is doubtful that such constraints will severely curtail the rockfish fishery. . Therefore, a more realistic prediction is that bycatch levels would be about the same as the baseline.

The habitat impacts model predicts the following effects for FMP 2.2 on biostructure relative to the baseline:

- **Bering Sea.** There is no predictable difference in impacts to habitat between FMP 2.2 and baseline conditions. For both, mean impacts are low when averaged over the entire fishable EEZ; impacts to biostructure ranged from 1.8 to 9.3 percent of the fishable EEZ and from 8.2 to 41.9 percent of the fished area. A large area in the Bering Sea (8,000 sq mi) that is subject to high fishing intensity potentially causes an 83 percent reduction in equilibrium biostructure level when a 15 year recovery rate is modeled. Based on these results, we conclude that there would be an insignificant change to mortality and damage to living habitat as a result of FMP 2.2.

- **Aleutian Islands.** There is no predictable difference in impacts to habitat between FMP 2.2 and from baseline conditions. For both, meaan impacts ranged from 1.1 to 6.8 percent of the fishable EEZ and from 5.4 to 32.6 percent of the fished areas. Therefore, we rate the change resulting from FMP 2.2 relative to the baseline as insignificant. However, prevalence of long-lived species of coral in the bycatch is a particular concern in the Aleutian Islands under FMP 2.2. With a recovery rate for red tree coral possibly as low as $\rho = 0.005$ (200 years) and sensitivity $q_H = 0.27$, the habitat impact model indicates that fishing intensity as low as $f = 0.10$ (total area swept once every 10 years) results in an equilibrium level reduction of 85 percent relative to the unfished level. About 9 percent of the area (3,590 sq mi) is estimated to be fished at $f = 0.10$ or greater. Thus, continued bycatch and damage to living habitat at FMP 2.2 bycatch levels may have negative consequences on habitat quality.

- **GOA.** There is no predictable difference in impacts too habitat between FMP 2.2 and baseline conditions. For both, mean impact on biostructure ranged from 0.9 to 6.9 percent of the fishable EEZ and from 3.8 to 29.0 percent of the fished areas. Only 2 percent of the fishable EEZ (2,418 sq mi) is potentially impacted to below 32 percent of unfished levels when a 15 year recovery rate is used. Therefore, for FMP 2.2, we rate this change in mortality and damage to living habitat as insignificant.

Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Identical to the baseline and FMP 1, FMP 2.2 closures in the Bering Sea are mostly concentrated on sand substrate (Table 4.5-47). Only 27 percent of the geographical habitat zones have at least 20 percent of their area closed to bottom trawling. Figure 4.1-10 shows that the amount of large contiguous areas of high fishing intensity—that is, areas that are swept at least once each year with bottom trawls—exceeds 8,000 sq mi (Table 4.1-26). Table 4.5-49 shows that, of the Bering Sea fishable area, 19.3 percent is closed to bottom trawling under FMP 2.2. However, very little geographic diversity of fishing impacts occurs within the closed habitats because the closed areas do not represent diverse closures of habitat (i.e., they are concentrated on sand substrate). In addition, very few of the closures are year-round. Figure 4.5-4 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.5-5 depicts just those areas closed to fixed gear only.

Application of the habitat impacts model indicated that, depending on plausible sensitivity and recovery parameters, fishing of this intensity could reduce the amount of biostructure in the area by 13 to 75 percent of its unfished equilibrium level (Table 4.5-48). Such biostructure includes sponges, soft corals, tunicates, and anemones (Heifetz 2002, Malecha *et al.* 2003). There are no existing closure areas adjacent to these intensely fished areas to provide a diverse level of impact. While existing closures tend to be large and cover all of a particular habitat, they provide little diversity in fishing impacts. The primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear; therefore, the closures do not necessarily cross a wide range of habitat types. Some of the trawl closures are in effect year-round while others are seasonal (see Section 3.6). Compared to the existing baseline, the predicted effects of FMP 2.2 on benthic community diversity is insignificant. Similarly, the predicted effects of FMP 2.2 on geographic diversity of impacts is also predicted to be insignificant.

- **Aleutian Islands.** Identical to the baseline and FMP 1, FMP 2.2 closures in the Aleutian Islands are concentrated in shallow water, where only 4 percent of the area is closed to bottom trawling year-round for all species. However, as shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutians is closed to bottom trawling at one time or another during the year under FMP 2.2. These closures are associated with sea lion rookeries. As in the baseline, there is very little diversity in protection. Less than one percent of the deep area is closed to bottom trawling. Figure 4.1-10 shows that none of the closure areas extend over any blocks of significant fishing effort. Figures 4.5-4 and 4.5-5 show the closure areas under FMP 2.2 broken down by gear type, bottom trawl and fixed gear, respectively. The Aleutian Islands bathymetry and habitat is distributed on a fine scale, with fishing effort that is patchy and in small clusters. Based on these observations relative to the baseline, the predicted effects of FMP 2.2 on benthic community diversity and geographic diversity of impacts are insignificant.

- **GOA.** Figure 4.5-6 shows that, as in the baseline, minimal geographic diversity of impact or protection results from the current suite of closed areas. Except for the southeast trawl closure, which covers several entire habitat types, all other closures are inshore (see Figure 4.5-6). As shown on Table 4.5-49 and Figures 4.5-4 and 4.5-5, FMP 2.2 closes nearly 46 percent of the fishable area in the GOA to trawling at one time or another during the year. The inshore closure areas tend to be large relative to the size of bathymetric and habitat resolution scale and thus tend to encompass a large portion of a bathymetric feature. Based on these results, the predicted effect of FMP 2.2 on benthic community diversity and geographic diversity of impacts is insignificant.

Cumulative Effects of FMP 2.2

Cumulative effects on habitat for FMP 2.2 are summarized on Table 4.5-50. The following discussion of the cumulative effects as presented on the table is broken down by geographic area.

Bering Sea

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. These effects include persistent mortality of long-lived species such as tree corals and other sessile epifauna (see the cumulative effects discussion for FMP 2.1).

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat (see the cumulative effects discussion for FMP 2.1).

- **Cumulative Effects.** Cumulative effects on mortality of Bering Sea benthic organisms are judged to be conditionally significant adverse. Additional external impacts will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though FMP 2.2 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue to negatively impact benthic living habitat.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. (See the cumulative effects discussion for FMP 2.1 for additional information.) Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities as described for FMP 2.1. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Cumulative effects on changes in benthic community structure of the Bering Sea are judged to be conditionally significant adverse. Additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though FMP 2.2 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue to negatively impact benthic living habitat.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. The cumulative effects section for FMP 2.1 provides additional discussion regarding past effects.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future external effects include port expansion and the potential resultant changes to fishing effort, offal discharge, and marine pollution episodes (see discussion for FMP 2.1). Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged to be conditionally significant adverse. The maps and statistics discussed under persistent past effects show that FMP 2.2 would protect more benthic habitat from trawl gear in the future (19 percent) than was protected in 1980 (8.6 percent). However, the spatial distribution of the closed areas under FMP 2.2 will not protect the full range of habitat types, or provide for a diversity of impacts within fished areas. Existing closures tend to be large and cover all of a particular habitat, and they provide little diversity in fishing impacts since the primary focus of past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear (see Direct/Indirect Effects discussion and baseline description in Section 3.6). Additional external impacts do not provide any protection and could add to the lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 2.2 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished, and impacts would occur in areas not previously impacted.

Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutians. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. See the FMP 2.1 cumulative effects discussion for additional information on these impacts.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat. See the FMP 2.1 discussion of cumulative impacts in the Aleutian Islands for additional details.

- **Cumulative Effects.** Cumulative effects on mortality of Aleutian Islands benthic organisms are judged to be conditionally significant adverse. Long-lived species, such as tree coral, are more prevalent in the Aleutian Islands. Additional external impacts will add to lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though FMP 2.2 is rated as insignificant, bycatch and damage to living habitat will continue to negatively impact benthic living habitat in the Aleutian Islands.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, dredging, longline and pot fisheries, offal discharge, port expansion and use, natural events, and marine pollution all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Cumulative effects on changes in benthic community structure of the Aleutians are judged to be conditionally significant adverse. Additional external impacts will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 2.2 are rated as insignificant, continued bycatch and damage to living habitat will increase negative impacts on the benthic community.

<u>Geographic Diversity of Impacts and Protection</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 31 percent of the fishable area in the Aleutians was closed to trawling, with about 6 percent closed to all fishing. There were no longline-only closures in the

Aleutian Islands at that time. The cumulative effects section for FMP 2.1 provides additional discussion regarding these past effects.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to fishing effort, offal discharge, and marine pollution episodes. See the discussion for cumulative effects of FMP 2.1 for additional details.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged conditionally significant adverse. The maps and statistics discussed udner persistent past effects show that FMP 2.2 would protect more benthic habitat from trawl gear in the future (43 percent) than was protected in 1980 (31 percent). However, the spatial distribution of the closed areas under the current FMPs may not protect the full range of habitat types.

GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see discussion for FMP 2.1).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 cumulative effects, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects.** Cumulative effects on mortality of GOA benthic organisms are judged to be conditionally significant adverse. Additional external impacts will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 2.2 are rated as insignificant, bycatch and damage to living habitat will continue in the GOA and will negatively impact benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 in the GOA, dredging, longline and pot fisheries, offal discharge, port expansion and use, natural events, and marine pollution all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the community.

- **Cumulative Effects.** Cumulative effects on changes in benthic community structure of the GOA are judged to be conditionally significant adverse. Additional external impacts will add to the lingering past impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 2.2 are rated as insignificant, bycatch and damage to living habitat in the GOA will continue to negatively impact the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, with about 7 percent closed to all fishing. The largest closures in the GOA were for longline fishing, where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980, about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at some time during the year (see discussion for FMP 2.1).

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future external effects include other fisheries, port expansion and the potential resultant changes to fishing effort, offal discharge, and marine pollution episodes (see the FMP 2.1 cumulative effects discussion for the GOA). Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged conditionally significant adverse. The maps and statistics discussed under persistent past effects show that FMP 2.2 would protect much more benthic habitat from trawl gear in the future (46 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under the FMP 2.2 may not protect the full range of habitat types. Also, in 1980 more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under FMP 2.2 (<1 percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. The additional external impacts will add to the lingering impacts and contribute to impacts that are already evident.

4.6.7 Seabirds Alternative 2 Analysis

4.6.7.1 Short-Tailed Albatross

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Incidental Take

The seabird protection measures for longline vessels under FMP 2.1 and FMP 2.2 would be the same as those that exist under the baseline conditions unless the USFWS requires a change in regulations under Section 7 of the ESA to protect the short-tailed albatross. For this analysis, it is assumed that the regulations will remain in effect as they were in 2002 (Section 3.7.1). Statistical analysis of the effectiveness of the baseline regulations in preventing incidental take of short-tailed albatross on longlines is problematic given the rarity of encounters. The issue would be even more difficult to resolve if observer coverage of fishing effort was decreased as proposed in FMP 2.1. It is clear, however, that the existing regulations have not eliminated the incidental take of short-tailed albatross. The fact that two short-tailed albatross were caught in one month in 1998 by vessels that were technically in compliance with the regulations indicates that the threat remains. The lack of performance standards in the existing regulations is considered a major limitation in the overall effectiveness of the techniques. Although education programs for fishermen in proper deployment methods could improve this situation, FMP 2.1 defines a very “hands-off” approach to fishery management where such training programs would be unlikely to occur. Using information from the projection model on Pacific cod TAC and qualitative assumptions about gear allocation within a basically unregulated fishery, the longline fishing effort in the BSAI under FMP 2.1 is predicted to be similar to the baseline longline effort, despite a major increase in overall groundfish harvest.

Longline effort in the GOA is predicted to almost double from the baseline effort under FMP 2.1. However, the baseline effort in the GOA is about seven times less than in the BSAI, and accounts for almost 20 times fewer birds taken incidentally. For these reasons, FMP 2.1 is considered to present the same or slightly increased risk of incidental take of short-tailed albatross on longlines as the baseline condition. Under FMP 2.2, longline effort is predicted to be about the same as under the baseline condition. The risk of incidental take of short-tailed albatross on longlines would therefore continue at the estimated rate of two birds per year under both FMP 2.1 and FMP 2.2; a rate that does not jeopardize the existence of the species but may slow its recovery (USFWS 1997).

There are presently no regulations that require any mitigation of seabird incidental take in either the trawl or pot sectors of the groundfish fleet, and no restrictions on these sectors would be implemented under FMP 2.1 or 2.2. Although no short-tailed albatross have been observed or reported to be taken in groundfish trawl gear, Laysan albatross are known to be taken in trawls, so the potential for taking the similar short-tailed albatross exists. In addition, NOAA Fisheries and USFWS are currently investigating whether collisions with trawl third wires pose a threat to short-tailed albatross, as these wires are known to cause mortality of other albatross. The level of bottom and pelagic trawl effort under FMP 2.1 is predicted to increase by 200 to 300 percent in the BSAI and remain about the same in the GOA (although there would be a shift of effort from bottom trawls to pelagic trawls). If the amount of trawl effort is directly proportional to the risk of taking albatross either in trawl gear or through vessel strikes, an assumption that has not yet been tested, this substantial increase in trawl effort under FMP 2.1 could pose an increased risk of taking short-tailed albatross. Such a change in the nature of the fishery would likely prompt a new Section 7 consultation with the USFWS. If USFWS determines that the trawl sector is likely to cause mortality of this endangered species, in addition to the mortality that is assumed and observed to occur in the longline fisheries, the combined incidental take in the groundfish fisheries could exceed the mortality threshold of four birds per two year period that was established in the last BiOp (USFWS 1997) and would likely be considered significant at the population level. Given the conjectural nature of these conditions occurring, FMP 2.1 is considered to be conditionally significant adverse for incidental take of short-tailed albatross from the groundfish fishery.

Under FMP 2.2, trawl effort is expected to increase by approximately 25 percent over the baseline condition. As with all matters concerning fishery interactions with this endangered species, the USFWS would have the responsibility under Section 7 of the ESA to review the proposed structure of the fishery and determine if the changes pose a significant risk to the continued existence of the species. While the outcome of those complex deliberations cannot be predicted at this time, it will be assumed that the modest increase in trawl effort proposed under FMP 2.2 would not be considered a substantial increase in risk for incidental take of the species. FMP 2.2 would therefore be considered to have insignificant effects on short-tailed albatross through incidental take.

Change in Food Availability

Short-tailed albatross forage over vast areas of ocean and are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 2.1 or 2.2, even if a directed forage fish fishery was developed. FMP 2.1 and FMP 2.2 are therefore considered to have insignificant effects on short-tailed albatross through availability of food.

Benthic Habitat

Short-tailed albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1 or FMP 2.2. FMP 2.1 and FMP 2.2 are therefore considered to have no effects on short-tailed albatross through benthic habitat.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on short-tailed albatross are described in Section 3.7.4 (Table 3.7-12) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for this species would be dominated by factors external to the groundfish fisheries and are summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 2.1, the risk of incidental take on longlines would be about the same or slightly greater than the baseline conditions. Risk of incidental take on trawl gear, however, would increase substantially. The overall risk of incidental take of short-tailed albatross is therefore considered conditionally significant adverse under FMP 2.1. Under FMP 2.2, the risk of incidental take would be the same or negligibly higher than the baseline conditions. Therefore, the overall risk of incidental take of short-tailed albatross is considered insignificant under FMP 2.2.

- **Persistent Past Effects.** The most important persistent influence on the short-tailed albatross population is their near extinction due to commercial feather hunting. Conservation efforts have allowed the population to recover at or near to its biologically maximum rate. The total fishery-related mortality of short-tailed albatross is unknown but it does not appear to be having an overriding effect on the population growth rate.

- **Reasonably Foreseeable Future External Effects.** The short-tailed albatross population may be substantially affected by several natural and human-caused mortality factors that may or may not occur in the future, including volcanic eruptions on their main breeding site, Torishima Island, and increased rates of incidental take in fisheries throughout their range. If the species experiences a substantial increase in mortality that threatens its recovery, it may lead to further efforts to protect the species from fishery interactions.

- **Cumulative Effects.** Since the population of short-tailed albatross is susceptible to several natural and human-caused mortality factors that may or may not occur in the future, including incidental take in the groundfish fisheries, the cumulative effect on short-tailed albatross is considered to be conditionally significant adverse at the population level through mortality for FMP 2.1 and FMP 2.2..

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 2.1 and FMP 2.2 and an unknown amount of forage fish under a potential directed fishery. This effect is considered insignificant at the population level for short-tailed albatross.

- **Persistent Past Effects.** Short-tailed albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to natural fluctuations in primary productivity and oceanographic factors. Pollution from a variety of land and marine sources have potentially affected short-tailed albatross prey in the past but specific toxicological effects are unknown.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on short-tailed albatross prey availability. Pollution is likely to affect short-tailed albatross prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to short-tailed albatross, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of short-tailed albatross prey is considered to be insignificant at the population level.

Benthic Habitat

Since short-tailed albatross feed at the surface and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for short-tailed albatross.

4.6.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Incidental Take

As described in Section 4.6.7.1, longline effort in the BSAI is expected to be about the same as under the baseline condition and is expected to almost double in the GOA under FMP 2.1. Incidental take of albatross on longlines is therefore expected to be the same as the baseline condition in the BSAI. Since there is not a strong correlation between fishing effort and incidental take of any species besides fulmars, the increased longline effort in the GOA may translate into similar or slightly increased levels of albatross take as the baseline condition. These levels of incidental take are considered insignificant at the population level for both species (see Section 4.5.7.2). FMP 2.1 is also expected to increase incidental take in trawl gear and vessel strikes due to a major increase in trawl effort. It is not known whether there is a direct proportional relationship between trawl effort and incidental take of albatross. However, if we assume that take levels would increase 300 percent in direct response to the increased level of trawl effort, take of Laysan albatross in trawls would average about 270 birds per year (Table 3.7-4, using the mean of low and high estimates). No black-footed albatross have been recorded as being taken in the combined trawl fisheries. Combining the expected increase in trawl mortality with the baseline level of longline take, the expected total take of Laysan albatross under FMP 2.1 would average approximately 1050 birds per year. This would represent an estimated 0.04 percent of their population (2.4 million birds) and is therefore considered insignificant on the population level. FMP 2.1 is therefore considered to have insignificant effects on both albatross species through overall incidental take.

Under FMP 2.2, the seabird protection measures, and level of effort for longline vessels would be the same as under the baseline condition. The predicted level of incidental take of both albatross species on longlines would therefore approximate the baseline levels described in Section 4.5.7.2, which are considered insignificant at the population level. Trawl effort is expected to increase under FMP 2.2 by approximately 25 percent over the baseline condition. If it is assumed that this increase in effort will result in a corresponding increase in incidental take, take of Laysan albatross in trawls would average about 112 birds per year (Table 3.7-4, using the mean of low and high estimates). This level of take is very small relative to the abundance of this species and is therefore considered to be insignificant at the population level. The overall effect of FMP 2.2 on both albatross species is therefore considered to be insignificant through incidental take.

Changes in Food Availability

Albatross forage over vast areas of ocean and are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 2.1 or 2.2, even if a directed forage fish fishery develops. FMP 2.1 and FMP 2.2 are therefore considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1 or FMP 2.2. FMP 2.1 and FMP 2.2 are therefore considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on these albatross species are described in Sections 3.7.2 and 3.7.3 (Tables 3.7-6 and 3.7-7) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-53) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under this alternative, the same seabird protection measures that are described in the baseline conditions (see Section 3.7.1) would be maintained. The predicted level of incidental take from all gear types is considered insignificant at the population level for both albatross species.

- **Persistent Past Effects.** For black-footed and Laysan albatross, past mortality factors include large contributions from foreign longline fisheries and Hawaiian pelagic longline fisheries, a smaller contribution from the BSAI/GOA longline fisheries, and an unknown contribution from other longline fisheries, trawl fisheries, and vessel collisions throughout their range. Both species have been experiencing population declines over the past decade. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown for both albatross species.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets and are expected to reduce take of albatross in those fisheries . Incidental take of black-footed and Laysan albatross in foreign longline fisheries is expected to remain high and continue to exceed the threshold for population level effects.

- **Cumulative Effects.** Since the populations of black-footed and Laysan albatross are undergoing measurable declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under FMP 2.1 and FMP 2.2, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 2.1 and FMP 2.2 and an unknown amount of forage fish in a potential directed fishery under FMP 2.1. This effect is considered insignificant at the population level for both albatross species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on albatross prey populations can not be assessed at this time.

- **Persistent Past Effects.** Albatross primarily prey on squid species and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since albatross can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources have potentially affected albatross prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on albatross prey availability. Pollution is likely to affect albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to albatross, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of albatross prey is considered to be insignificant at the population level for all species.

<u>Benthic Habitat</u>

Since albatross feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on albatross prey. Therefore, no cumulative effect is identified for these species.

4.6.7.3 Shearwaters

Direct/Indirect Effects of FMP 2.1 and 2.2

<u>Incidental Take</u>

As described in Section 4.6.7.1, longline effort in the BSAI is expected to be about the same as under the baseline condition, and is expected to almost double in the GOA under FMP 2.1. Incidental take of shearwaters on longlines is therefore expected to be the same as the baseline condition in the BSAI. Since there is not a strong correlation between fishing effort and incidental take of any species besides fulmars, the increased longline effort in the GOA may translate into similar or slightly increased levels of shearwater take as the baseline condition. These levels of incidental take are considered insignificant at the population level for both species (see Section 4.5.7.2). FMP 2.1 is also expected to increase incidental take in trawl gear and vessel strikes due to a major increase in trawl effort. It is not known whether there is a direct proportional relationship between trawl effort and incidental take of shearwaters. However, if we assume that take levels would increase 300 percent in direct response to the increased level of trawl effort, take of shearwaters in trawls would average about 2,400 birds per year (Table 3.7-4, using the mean of low and high estimates). These levels of take are very small relative to the abundance of these species (estimated at a combined 54 million birds) and are therefore considered to be insignificant at the population level. FMP 2.1 is therefore considered to have insignificant effects on these species through overall incidental take.

Under FMP 2.2, the seabird protection measures for longline vessels would be the same as the baseline condition and longline effort is predicted to be about the same as under the baseline condition. The predicted level of incidental take of these shearwater species on longlines would therefore approximate the baseline levels described in Section 4.5.7.2, which are considered insignificant at the population level. Trawl effort is expected to increase under FMP 2.2 by approximately 25 percent over the baseline condition. If it is assumed that this increase in effort will result in a corresponding increase in incidental take, take of shearwaters in trawls would average about 1000 birds per year (Table 3.7-4, using the mean of low and high estimates). This level of take is very small relative to the abundance of these species and is therefore considered to be insignificant at the population level. The overall effect of FMP 2.2 on these species is therefore considered to be insignificant through incidental take.

Changes in Food Availability

Shearwaters forage over vast areas of ocean and are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 2.1 or FMP 2.2, even if a directed forage fish fishery develops. FMP 2.1 and FMP 2.2 are therefore considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Shearwaters are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1 or FMP 2.2. FMP 2.1 and FMP 2.2 are therefore considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on these shearwater species are described in Section 3.7.6 (Table 3.7-14) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described above (Table 4.5-54). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-54) and summarized below.

Mortality

- **Direct/Indirect Effects**. Under this alternative, the same seabird protection measures that are described in the baseline conditions (see Section 3.7.1) would be maintained. The predicted level of incidental take from all gear types is considered insignificant at the population level for both species in this group.

- **Persistent Past Effects.** For sooty and short-tailed shearwaters, mortality factors include large contributions from subsistence and commercial harvest of chicks on the nesting grounds as well as climatic and oceanic fluctuations that cause periodic mass starvation, substantial contributions from foreign, Hawaiian, and BSAI/GOA groundfish longline and trawl fisheries, and a smaller contribution from vessel collisions throughout their range. It is difficult to assess the population trends in these abundant and widespread species but there is some indications that both species may be declining. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets but they are not expected to reduce take of shearwaters in those fisheries. Incidental take of shearwaters in foreign fisheries will likely continue as in the past unless longline and trawl deterrence techniques are developed and applied that are effective for diving species.

- **Cumulative Effects.** Since the populations of shearwaters may be undergoing declines, and several human-caused mortality factors have been identified that are expected to continue in the future, including contributions from the groundfish fisheries under FMP 2.1 and FMP 2.2, the cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally significant adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid as bycatch under FMP 2.1 and FMP 2.2, even with a potential directed forage fish fishery under FMP 2.1. This effect is considered insignificant at the population level for both species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on shearwater prey populations can not be assessed at this time.

- **Persistent Past Effects.** Short-tailed and sooty shearwaters are susceptible to periodic widespread food shortages that have caused massive die-offs in Alaskan waters. Natural fluctuations in primary productivity and oceanographic factors are considered to be the driving forces that determine the abundance of their main prey (euphausiids), rather than competitive interactions with other predators. Since shearwaters can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on shearwater prey availability. Pollution is likely to affect shearwater prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to shearwaters, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of shearwater prey is considered to be insignificant at the population level for both species.

Benthic Habitat

Since shearwaters feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.6.7.4 Northern Fulmar

Direct/Indirect Effects of FMP 2.1

Incidental Take

Mortality of northern fulmars on longline gear accounts for the majority of all birds taken incidentally in the groundfish fisheries under the baseline conditions. Under FMP 2.1, incidental take on longlines is predicted to remain similar to its present level because of similar effort and avoidance measures as the baseline condition (see Section 4.5.7.3). Incidental take in trawl gear and by vessel strikes (about 3150 fulmars per year under baseline conditions) is expected to increase by an unknown amount with the predicted 200 to 300 percent increase in trawl effort under FMP 2.1. Even if we assumed a direct relationship with trawl effort that resulted in a 300 percent increase in fulmar take, the overall numbers of fulmars taken in the groundfish fishery would still be small relative to their abundance in the BSAI/GOA (close to one percent of their estimated 2 million population). Fulmar population dynamics, and the potential effects of different levels of mortality or mortality of adults versus subadults, have not been explored with mathematical modeling. Given the fact that fulmar population trends are presently measured only on the Pribilofs and not on their largest colonies, it is unlikely that anthropogenic mortality equal to an estimated one percent of their population would have a detectable effect on the overall population. However, concern for a colony level effect would be intensified (see Section 4.5.7.3), especially since the existing fishing restrictions around the Pribilof Islands would be lifted under FMP 2.1. If trawl and longline effort increased substantially around the Pribilofs during the breeding season and a high percentage of the incidentally taken fulmars came from the Pribilof colony, incidental take of fulmars under FMP 2.1 could be significant at the colony level. Given the conjectural nature of these conditions occurring, FMP 2.1 is considered to be conditionally significant adverse for incidental take of fulmars.

Changes in Availability of Food

Fulmars forage over vast areas of ocean and are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 2.1, even if a directed forage fish fishery develops. FMP 2.1 is therefore considered to have insignificant effects on fulmars through availability of food.

Benthic Habitat

Fulmars are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1. FMP 2.1 is therefore considered to have no effects on fulmars through benthic habitat.

Cumulative Effects of FMP 2.1

The past/present effects on northern fulmars are described in Section 3.7.5 (Table 3.7-13) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.6-4 and summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 2.1, the same seabird protection measures for the longline fleet that are described in the baseline conditions (section 3.7.1) would be maintained. The incidental take of fulmars under FMP 2.1 is expected to be similar to the baseline level in the longline sector, and much higher in the trawl sector due to increased effort. The overall effect of the fishery on fulmar mortality is considered conditionally significant adverse because of increased concern for colony level effects.

- **Persistent Past Effects.** For northern fulmars, past mortality factors include large contributions from the BSAI/GOA groundfish fisheries and other net and longline fisheries in the North Pacific and Bering Sea. There is no indication of an area-wide population decline, but there is some concern that particular colonies may be experiencing declines related to the groundfish fisheries. Other potential mortality factors that have been identified include acute and chronic effects of pollution, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation) due climatic and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Incidental take of fulmars is expected to continue in all offshore fisheries in the BSAI/GOA. The IPHC fisheries will be subject to new seabird avoidance measures, so incidental take from the halibut and sablefish fleet is expected to decline substantially. Future oil spills and other incidents of pollution are likely, but their effects on fulmars will depend on many factors that can not be predicted.

- **Cumulative Effects.** Incidental take in the groundfish fishery under FMP 2.1 is expected to be the primary human-caused mortality factor for fulmars. Because fishing intensity is expected to increase substantially around the Pribilof Islands, the cumulative effect on fulmar mortality is considered conditionally significant adverse because of increased concern for colony level effects.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch under FMP 2.1, and an unknown amount of these prey if a directed forage fish fishery developed. This effect is considered insignificant at the population level for northern fulmars. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on fulmar prey populations can not be assessed at this time.

- **Persistent Past Effects.** Fulmars prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since fulmars can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources have potentially affected fulmar prey in the past. However, very little is known about the specific toxicological effects on species important to fulmars or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on fulmar prey availability. Pollution is likely to affect fulmar prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to fulmars, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of fulmar prey is considered to be insignificant at the population level.

Benthic Habitat

Since fulmars feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernible effect on their prey. Therefore, no cumulative effect is identified for this species.

Direct/Indirect Effects of FMP 2.2

Incidental Take

For the reasons described above, the incidental take of fulmars on longlines under FMP 2.2 would be expected to be approximately the same as described under the baseline conditions (Section 4.5.7.3). This level is considered insignificant at the population level for fulmars. Trawl effort is expected to increase under FMP 2.2 by approximately 25 percent over the baseline condition. If we assume that this increase in effort will result in a corresponding increase in incidental take, take of fulmars in trawls and vessel strikes would average about 4,000 birds per year. The combined take from longlines and trawls would be approximately 16,000 birds per year (see Section 4.5.7.3) which is less than one percent of the estimated BSAI/GOA population of 2 million birds.

This level of take would be considered insignificant at the population level. However, there would still be concern about potential colony level effects and the USGS/BRD would likely continue to investigate the issue. The existing trawl restrictions around the Pribilof Islands would be maintained under FMP 2.2 so the increase in trawl effort would not be concentrated near the fulmar colony. While these investigations continue, it will be assumed for this analysis that FMP 2.2 would not lead to a disproportionate take of fulmars from any one colony. The overall effect of FMP 2.2 on fulmars is therefore considered to be insignificant through incidental take.

Changes in Availability of Food

FMP 2.2 would have the same insignificant effects on fulmar food availability as described above for FMP 2.1

Benthic Habitat

FMP 2.2 would have no effects on fulmar benthic habitat as described above for FMP 2.1.

Cumulative Effects – FMP 2.2

Mortality

- **Direct/Indirect Effects.** The seabird protection measures under FMP 2.2 would be the same as described above for FMP 2.1. However, the structure and intensity of the fisheries would be substantially different than FMP 2.1. Although concern for colony level effects remain, the effect of the fishery under FMP 2.2 is considered insignificant at the population level.

- **Persistent Past Effects and Reasonably Foreseeable Future External Effects.** These effects would be the same as described above for FMP 2.1.

- **Cumulative Effects.** Incidental take in the groundfish fishery under FMP 2.2 is expected to be the primary human-caused mortality factor for fulmars. Incidental take in the IPHC fisheries is expected to decrease, and at least partially compensate for, the small increase in take expected in the groundfish fishery. The cumulative effect on fulmar mortality is therefore considered insignificant at the population level.

Changes in Food Availability and Benthic Habitat

These effects would be the same as described above for FMP 2.1.

4.6.7.5 Species of Management Concern (Red-Legged Kittiwakes, Marbled and Kittlitz's Murrelets)

Direct/Indirect Effects of FMP 2.1

Incidental Take

The seabird avoidance measures under FMP 2.1 would be the same as under the baseline conditions and would be limited to the longline fleet. Under the baseline conditions, no red-legged kittiwakes have been observed to be taken in any of the BSAI/GOA fisheries since data began to be collected in 1993. Under FMP 2.1, longline effort would remain about the same as the baseline in the BSAI, while trawling would increase substantially. The Pribilof Habitat Conservation Area, which covers a large area around the largest red-legged kittiwake colony on St. George Island, would be eliminated along with many other fishery closures. The elimination of this closed area would result in an increased potential for incidental take of red-legged kittiwakes around the Pribilof Islands. However, since incidental take approaches zero under the current conditions, it appears that the species is not very susceptible to being taken in any gear, perhaps because they can not compete for offal with the larger gulls or are more agile in avoiding entanglement. It seems most likely that these birds will continue to be able to successfully avoid being taken on a regular basis, even with increased fishing effort. The effect of FMP 2.1 on incidental take of red-legged kittiwakes is therefore considered insignificant at the population level.

Murrelets, due to their small size and feeding strategy, are more susceptible to being taken in trawls than in either longline or pot fisheries. The 200 to 300 percent increase in trawling under FMP 2.1 would result in an increased potential for incidental take of these species. However, since murrelets prefer to forage in waters inshore of the groundfish fisheries, and the incidental take of murrelets under the baseline conditions already approaches zero, the potential increase in take would likely be very small. The effect of FMP 2.1 on incidental take of marbled and Kittlitz's murrelets is therefore considered insignificant at the population level.

Changes in Food Availability

Given the wide variety of foods used by kittiwakes and the extensive areas over which they forage, it seems unlikely, even with the substantial increased trawling activity, that they would be susceptible to localized depletion of prey during the non-breeding season. However, while nesting, kittiwakes are more dependent on high-quality forage fish for raising chicks and are more susceptible to potential localized depletions of prey around their colonies. Elimination of the Pribilof Habitat Conservation Area fishery closure would likely result in increased trawling around the largest red-legged kittiwake colony, St. George Island. More importantly than trawl bycatch, the existing ban on the development of a directed forage fish fishery would be lifted under FMP 2.1. It is not clear how such a fishery would be structured or how extensive it would become (see Section 4.6.4), but if such a fishery developed around the Pribilofs it could have serious repercussions on the availability of prey to red-legged kittiwakes and could have population level effects. Because of the conjectural nature of this situation developing, the potential effect of the fishery through prey availability is rated conditionally significant adverse.

The groundfish fisheries have very little spatial overlap with murrelet foraging areas, but they do depend on forage fish schools that likely spend part of their time in waters of the EEZ. If a directed forage fish fishery developed near murrelet habitats in southeast Alaska and the GOA, forage fish populations may be affected on a regional level and could potentially affect murrelet reproductive success. As described above for kittiwakes, the potential effect of the fishery through prey availability is rated conditionally significant adverse for marbled and Kittlitz's murrelets.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles. However, benthic habitats in their nearshore foraging areas would not be affected directly by groundfish trawls under FMP 2.1, as these take place further offshore. FMP 2.1 is therefore considered to have insignificant effects on murrelets through benthic habitat, and no effects on red-legged kittiwakes.

Cumulative Effects of FMP 2.1

The past/present effects on red-legged kittiwakes, marbled murrelets, and Kittlitz's murrelets are described in Sections 3.7.13 and 3.7.17 (Tables 3.7-22 and 3.7-26) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above (Table 4.6-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.6-4) and summarized below.

Mortality

- **Direct/Indirect Effects.** The incidental take of red-legged kittiwakes and both murrelets species is expected to be rare and therefore insignificant at the population level under FMP 2.1.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging (red-legged kittiwakes), incidental take in coastal salmon gillnet and other net fisheries (murrelets), oil spills (murrelets), and logging of nest trees (marbled murrelets). Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed very little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. For red-legged kittiwakes, the introduction of nest predators or a large oil spill around the Pribilof Islands in nesting season could have significant effects on mortality. For the murrelet species, oil spills in nearshore habitats and incidental take in salmon and other net fisheries are likely to remain the largest factors in the future. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality. If the Kittlitz's murrelet population continues to decline and the species is listed under the ESA, new regulations may be placed on the various nearshore net fisheries to monitor and reduce incidental take of the species. These measures would also benefit marbled murrelets.

- **Cumulative Effects.** The three species in this group have all experienced substantial population declines in the recent past, and are all susceptible to future human-caused mortality factors, including potentially small contributions from the groundfish fishery. The decline of red-legged kittiwakes on the Pribilofs may have been reversed recently, but it is not clear if their recovery will continue in the future. The cumulative effect for red-legged kittiwakes is therefore considered conditionally significant adverse at the population level through mortality. Both murrelet species continue to decline in their core areas, and are thus considered to have significantly adverse cumulative effects at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** A directed forage fish fishery could develop under this FMP that could lead to population level effects on all three species. The effect of FMP 2.1 is therefore considered conditionally significant adverse at the population level for all three species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All three species prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, have likely affected the prey of these species in the past. Since murrelets are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded murrelets from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The dynamic interaction of natural and human-caused events, including fisheries and pollution, on the availability of forage fish and invertebrate prey to seabirds is only beginning to be explored with directed research. However, the potential of the groundfish fisheries under FMP 2.1 to have a significantly adverse effect on prey availability leads to a cumulative effects rating of conditionally significant adverse for these three species.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery. Therefore, no cumulative effect is identified for red-legged kittiwakes. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles, but they forage in shallow waters that are inshore of the groundfish fishery. Since the groundfish fishery would have minor contributions to potential effects on benthic habitats important to murrelets, the cumulative effects for these species are considered insignificant.

Direct/Indirect Effects of FMP 2.2

Incidental Take

Under FMP 2.2, longline fishing effort would be similar to the baseline in both the BSAI and GOA. Incidental take of red-legged kittiwake would therefore be similar to the baseline, which approaches zero. Trawl effort would increase by a modest amount under FMP 2.2 but, as described above for FMP 2.1, would not be expected to substantially increase incidental take of murrelets or kittiwakes. The effect of FMP 2.2 on incidental take of these species is therefore considered insignificant at the population level.

Availability of Food

As described in Section 4.5.7.4, the potential effects of the groundfish fishery on kittiwake and murrelet prey availability are considered to be insignificant under the baseline conditions. Although trawl effort is predicted to increase by 25 percent under FMP 2.2, it is unlikely that the attendant increase in bycatch of forage fish would affect prey availability enough to cause population level effects on these species (see Sections 4.6.4 and 4.6.10). The existing ban on the development of a directed forage fish fishery would remain in effect under FMP 2.2. The overall effect of FMP 2.2 on the availability of food for species of management concern is therefore considered insignificant at the population level.

Benthic Habitat

There are no effects on these species through benthic habitat under FMP 2.2, as described above for FMP 2.1.

Cumulative Effects of FMP 2.2

The seabird protection measures under FMP 2.2 would be the same as described above for FMP 2.1. The cumulative effects for mortality of these species are dominated by factors external to the fishery and would lead to the same conclusions as described above for FMP 2.1. Without the potential for a directed forage fish fishery, the potential effects of FMP 2.2 on prey availability are unknown, and lead to a cumulative effects rating of unknown. The groundfish fishery only makes a minor contribution to effects on benthic habitat, so insignificant cumulative effects are identified for murrelet species. No cumulative effect is identified for red-legged kittiwakes because they are not benthic feeders (Table 4.5-56).

4.6.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of FMP 2.1

Incidental Take

The incidental take of piscivorous seabirds on longlines under FMP 2.1 would be expected to be similar to the baseline levels which are considered insignificant at the population level for these species (see Section 4.5.7.5). Incidental take in trawls would be expected to increase from baseline conditions due to increased trawl effort, but would not be expected to have population level effects for any species in this group because of the very low levels of take relative to the populations of these abundant species. For these reasons, FMP 2.1 is considered to have insignificant effects on piscivorous species through incidental take.

Changes in Food Availability

As described in Section 4.5.7.5, the potential effect of the groundfish fishery on piscivore prey availability is considered to be insignificant under the baseline conditions. The availability of food in the form of fishery discards would be expected to increase substantially with the overall increase in TAC under FMP 2.1. Some species of large gulls may benefit on the population level from this increase in supplemental food supplies while other species, like kittiwakes and murres, experience an adverse effect from increased predation pressure from the large gulls. The net beneficial or adverse effects of fishery wastes to the different species in this group are unknown.

Although trawl effort is predicted to increase substantially under FMP 2.1, bycatch of forage fish and pelagic invertebrates in groundfish trawls is not expected to affect the abundance and distribution of forage fish enough to cause population level effects on piscivores (see Sections 4.6.4 and 4.6.10). However, the existing ban on the development of a directed forage fish fishery would be lifted under FMP 2.1. It is not clear how such a fishery would be structured or how extensive it would become. Under certain conditions, such a fishery could result in localized depletions of forage fish important to seabirds that could have population level effects, especially if they occurred near breeding colonies during chick-rearing season. Because of the conjectural nature of this situation developing, the potential effect of the fishery through prey availability is rated conditionally significant adverse.

Benthic Habitat

Cormorants and alcids sometimes feed in the demersal zone, and some of their prey depend on benthic habitats during various life cycle stages. Bottom trawling and pelagic trawling that makes contact with the ocean bottom have the greatest potential to indirectly affect these diving seabirds via physical changes to the complexity and productivity of benthic habitats that may affect their prey base (NRC 2002). Although area-specific effects of trawling on seabird prey species (through habitat change rather than by direct take) are poorly known, overall trawl effort in the BSAI/GOA under FMP 2.1 is predicted to increase 200 to 300 percent relative to the baseline condition and, since the effects of repeated trawling are cumulative, benthic habitat important to diving seabirds could be affected substantially over time. The overall effects of increased trawling under FMP 2.1 are therefore considered conditionally significant adverse on piscivorous seabirds.

Cumulative Effects of FMP 2.1

The past/present effects on the species in this group, including most alcids, gulls, and cormorants, are described in the species accounts of Section 3.7 (Tables 3.7-16 and 3.7-20) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.6-4 and summarized below.

<u>Mortality</u>

- **Direct/Indirect Effects.** Although incidental take of alcids is expected to increase under FMP 2.1 due to increased trawl effort, the incidental take of all species in this group is expected to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging, incidental take in a variety of foreign and U.S. coastal and pelagic fisheries, oil spills and other pollution (including huge losses at some colonies from the EVOS, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. Conservation concerns focus on preventing potential impacts around breeding colonies during the nesting season since populations are concentrated in time and space. For some species, human impacts in nearshore habitats will likely have a much greater effect on their populations than offshore fisheries. The contribution from chronic sources of pollution, from both terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are therefore considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** Because of the potential development of directed forage fish fisheries, the effect of FMP 2.1 on the abundance and distribution of seabird prey species is considered conditionally significant adverse at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All species in this group prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources have likely affected the prey of these species in the past. Since some of the alcids are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded them from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries, as well as other net fisheries that take forage fish as bycatch, may have an effect on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** Since the groundfish fisheries under FMP 2.1 may include a directed fishery on forage fish, the effects of which are potentially adverse under certain conditions, the cumulative effects on prey availability are considered to be conditionally significant adverse for these species.

Benthic Habitat

- **Direct/Indirect Effects.** Trawl effort would increase substantially under FMP 2.1, and would have the potential to modify benthic habitats and have indirect effects on the food web of diving piscivorous species. The overall effects of FMP 2.1 on piscivorous seabirds through potential changes in benthic habitat are considered conditionally significant adverse.

- **Persistent Past Effects.** Benthic habitats important to the diving species in this group have been affected by various foreign and U.S. fisheries for many years, and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to seabirds. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may also have persistent effects in certain areas.

- **Reasonably Foreseeable Future External Effects.** All future fisheries in the BSAI/GOA that use bottom contact fishing gear are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects.** Since the groundfish fisheries under FMP 2.1 will contribute in a potentially significant way to the many human-caused and natural factors that may alter benthic habitats, the cumulative effects of these changes as they relate to the food web important to piscivorous seabirds are considered conditionally significant adverse.

Direct/Indirect Effects of FMP 2.2

Incidental Take

The incidental take of piscivorous seabirds under FMP 2.2 would be expected to remain approximately the same as the baseline levels which are considered insignificant at the population level for these species (see Section 4.5.7.5).

Changes in Food Availability

As described in Section 4.5.7.5, the potential effects of the groundfish fishery on piscivore prey availability are considered to be insignificant under the baseline conditions. The availability of food in the form of fishery discards would be expected to increase in proportion to the overall increase in TAC under FMP 2.2. Some species of large gulls may benefit on the population level from this increase in supplemental food supplies while other species, like kittiwakes and murres, experience an adverse effect from increased predation pressure from the large gulls. The net beneficial or adverse effects of fishery wastes to the different species in this group are unknown.

Although trawl effort is predicted to increase by 25 percent under FMP 2.2, the attendant increase in bycatch of forage fish and pelagic invertebrates is not expected to affect prey availability enough to cause population level effects on piscivores (see Sections 4.6.4 and 4.6.10). The existing ban on the development of a directed forage fish fishery would remain in effect under FMP 2.2. The overall effect of FMP 2.2 on the availability of food for piscivorous species is therefore considered insignificant on the population level.

Benthic Habitat

Trawl effort in the BSAI/GOA is predicted to increase by 25 percent under FMP 2.2 relative to the baseline condition. This level of increase is not expected to produce a substantial change in the nature or intensity of trawl impacts relative to the baseline. The effect of FMP 2.2 on benthic habitat important to piscivorous seabirds is therefore considered insignificant.

Cumulative Effects of FMP 2.2

The only factors of the cumulative effects analysis for FMP 2.2 that would vary from those described above for FMP 2.1 are the contributions of the groundfish fishery. The contributions of the fishery to direct mortality, prey availability, and benthic habitat are all considered insignificant at the population level under FMP 2.2. Since the combination of past events have not resulted in population level effects, and no foreseeable future events are likely to change the situation, the cumulative effects of mortality, prey availability, and benthic habitat under FMP 2.2 are considered insignificant (Table 4.5-57).

4.6.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of FMP 2.1 and 2.2

Incidental Take

As described in Section 4.5.7.6, the incidental take of planktivorous species is very small under the baseline conditions relative to their abundance in the BSAI/GOA. Under FMP 2.1 and FMP 2.2, trawl effort would increase while longline effort is predicted to remain similar to the baseline level. Since very few storm-petrels or auklets are taken in either the longline or trawl fisheries, the predicted changes in fishing effort would be unlikely to result in substantial changes in take from the baseline conditions. The increased trawl effort could lead to an increase in bird mortality from vessel strikes, but it is unlikely that this would have population level effects given the infrequent nature of the events and relatively small numbers of birds involved (Section 4.5.7.6). The overall effect of FMP 2.1 or FMP 2.2 on the incidental take of planktivorous species is therefore considered insignificant at the population level.

Changes in Food Availability

The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch under FMP 2.1 and FMP 2.2. FMP 2.1 would also remove the ban on development of directed forage fish fisheries. Although it is not known whether such a fishery would actually develop or what its structure and intensity would be, it would likely take a higher rate of seabird prey as bycatch than other target fisheries. However, it is unlikely that a forage fish fishery would have more than a negligible effect on the availability of prey to planktivorous seabirds.

One potential connection between the groundfish fishery and the abundance of planktonic prey for these seabird species is described in Section 4.5.7.6. The groundfish fisheries could indirectly affect the availability of zooplankton and small schooling fish to seabirds through changes in the abundance and distribution of target fish species that also prey on small fish and zooplankton. For example, since young pollock are planktivores, it could be argued that changes in fishery management that led to decreased abundance of pollock populations (e.g., greater fishing effort) would decrease competition for prey and hence improve the carrying capacity for storm-petrels and auklets. However, zooplankton and juvenile fish abundance and distribution are thought to be influenced much more by primary productivity and oceanographic fluctuations than predator/prey relationships (see 3.7.1). The effects of the fisheries on prey availability for planktivorous seabird species, as managed under FMP 2.1 or FMP 2.2, are therefore expected to be insignificant on the population level for these seabird species.

Benthic Habitat

Storm-petrels and auklets are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1 or FMP 2.2. Therefore, both FMPs are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on the species in this group are described in Sections 3.7.7 and 3.7.18 (Tables 3.7-15 and 3.7-27) and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-58 and summarized below.

Mortality

- **Direct/Indirect Effects.** Although incidental take of alcids is expected to increase due to increased trawl effort, the incidental take of all species in this group is expected to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in foreign and U.S. coastal and pelagic fisheries, oil spills and other marine pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are therefore considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** FMP 2.1 would remove the ban on development of directed forage fish fisheries. Although it is not known whether such a fishery would actually develop or what its structure and intensity would be, it would likely take a higher rate of seabird prey as bycatch than other target fisheries. However, it is considered unlikely that a forage fish fishery would have more than a negligible effect on the availability of prey to planktivorous seabirds. Indirect effects on zooplankton and juvenile fish abundance through changes in the abundance of target fish predators is considered minor compared to seasonal changes in primary productivity and oceanographic factors. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group.

- **Persistent Past Effects.** Factors that have affected the abundance and distribution of zooplankton and juvenile fish include bycatch in squid and forage fish fisheries, marine pollution, and the decimation of planktivorous whales by commercial whaling. These effects are considered minor compared to seasonal and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have minimal effects on prey availability for these species. Pollution is also likely to affect prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute in an indirect way to human influences on planktonic prey availability, which are considered minimal compared to natural fluctuations. These cumulative effects are considered insignificant on the population level for all species in this group.

Benthic Habitat

Since these planktivorous seabirds feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effects are identified for these species.

4.6.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of FMP 2.1 and 2.2

Incidental Take

Spectacled eiders interact very little, if at all, with the groundfish fisheries under the baseline conditions (see Section 4.5.7.7). There are no changes in the fishery under FMP 2.1 or FMP 2.2 that would be expected to affect this situation. The groundfish fisheries are therefore expected to have incidental take of spectacled eiders approaching zero under FMP 2.1 and FMP 2.2.

Steller's eider have very little overlap between their foraging areas and the groundfish fisheries, and have thus been taken very rarely under the baseline conditions (see Section 4.5.7.7). In the one area that overlaps with the groundfish fishery, Kuskokwim Shoals, the fishery has not been restricted in the past but has been limited by its distance from ports of delivery and lack of interest by the fleet. An increase in the overall TAC is therefore not likely to lead to a proportional increase in effort in Kuskokwim Shoals. Incidental take of Steller's eider is therefore expected to continue to be very rare under FMP 2.1 and FMP 2.2, and is considered to have insignificant effects on their population levels.

Changes in Food Availability

The groundfish fisheries are not expected to overlap in space or time with spectacled eider critical habitat under FMP 2.1 or FMP 2.2. Therefore, no effects on spectacled eider food availability have been identified. Since there would be very little overlap between groundfish fisheries and critical habitat for Steller's eiders under FMP 2.1 or 2.2, the effects of the groundfish fisheries on prey abundance and availability are considered insignificant at the population level.

Benthic Habitat

As discussed in Section 4.5.7.7, there has been no overlap between the groundfish trawl fisheries and spectacled eider habitat. Neither FMP 2.1 nor FMP 2.2 are expected to change this situation, and are therefore considered to have no effects on spectacled eiders through benthic habitat changes.

For Steller's eiders, potential trawl effort in their critical habitat is limited to Kuskokwim Bay. Since the fishery in this area is not restricted under the baseline conditions and has been apparently limited only by lack of interest from the fleet, no changes in management under FMP 2.1 or FMP 2.2 would promote an increase use of this area. Potential effects are therefore likely to remain similar to the baseline condition and are considered insignificant.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on spectacled and Steller's eiders are described in Sections 3.7.9 and 3.7.10 (Tables 3.7-17 and 3.7-18) and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-59 and summarized below.

<u>Mortality</u>

- **Direct/Indirect Effects.** Although incidental take of diving seabirds is expected to increase under FMP 2.1 and FMP 2.2 due to a major increase in trawl effort, this additional fishing is not expected to take place in areas important to eiders. Incidental take of spectacled eider is predicted to remain at or near zero. Incidental take of Steller's eider is expected to be very rare under FMP 2.1 and FMP 2.2, and is therefore considered to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include sport hunting and subsistence harvest in Russia and Alaska, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution that causes physiological stress and reduces survival rates, lead shot poisoning on the nesting grounds, and collisions with vessels and other structures. Incidental take in the BSAI/GOA groundfish fisheries appears to have been very rare for Steller's eider. Both species have been afforded protection through the ESA.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns focus on preventing potential impacts in critical habitat areas.

- **Cumulative Effects.** The groundfish fisheries do not contribute to direct mortality of spectacled eiders, so no cumulative effect is identified for that species. Decreased adult survival rates appear to have driven the past population decline of Steller's eiders. Known sources of direct human-caused mortality of Steller's eider, including very rare incidental take in the groundfish fisheries, do not appear to account for the past population decline in Alaska. However, several indirect factors may be contributing to decreased adult survival rates, including climate-induced changes in habitat, concentration of predators around nesting areas due to nearby human habitation, and pollution of nearshore waters from chronic and periodic sources of petroleum products (USFWS 2003a). Since the Alaska breeding population of Steller's eiders has declined dramatically in the past and has not recovered, and because several human-induced sources of mortality have been identified as potential contributing factors to this decline, including the potential for contributions to pollution and vessel collisions from the groundfish fisheries as managed under FMP 2.1 and FMP 2.2, the cumulative effects of mortality on Steller's eiders are considered significant adverse at the population level.

Changes in Food Availability

The abundance of marine invertebrate species important to Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. Although other factors external to the fisheries may influence the abundance and distribution of eider prey, the groundfish fisheries only contribute minimally to these potential effects. Therefore, an insignificant cumulative effect on prey availability is identified for Steller's eiders. There is no overlap predicted between the groundfish fisheries and spectacled eider critical habitat, therefore, no cumulative effect has been identified for spectacled eider food availability.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, disrupt benthic habitats that support the prey of eiders. Under FMP 2.1 and FMP 2.2, the groundfish fishery is not expected to occur in spectacled eider critical habitat or any other area that they typically use. A limited amount of bottom trawling is expected to overlap with Steller's eider critical habitat. The overall effects of FMP 2.1 and FMP 2.2 on Steller's eiders through potential changes in benthic habitat are considered insignificant at the population level.

- **Persistent Past Effects.** Benthic habitats important to spectacled and Steller's eiders have been affected by various trawl and pot fisheries for many years, and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to eiders. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may also have persistent effects in certain areas. Climate change and ocean temperature fluctuations may also play a role in altering the benthic environment.

- **Reasonably Foreseeable Future External Effects.** All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects.** There is no overlap predicted between spectacled eider critical habitat and the groundfish fisheries under FMP 2.1 and FMP 2.2, therefore no cumulative effect on benthic habitat has been identified for this species. While the groundfish fisheries are predicted to have little spatial overlap with Steller's eider habitat under FMP 2.1 or FMP 2.2, the interaction of human-caused and natural disturbances of benthic habitat important to Steller's eiders has not been examined with respect to their population declines in the past. The cumulative effects of benthic habitat disruptions over the years as they relate to the food web important to eiders are therefore considered to be unknown.

4.6.8 Marine Mammals Alternative 2 Analysis

4.6.8.1 Western Distinct Population Segment of Steller Sea Lions

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

The analysis used to determine changes in the level of incidental takes described in Section 4.5.8 was applied to establish the significance of incidental take and entanglement of marine mammals expected to occur under FMP 2.1. With regard to incidental take, FMP 2.1 is not likely to result in significant changes to the population trajectory of the western distinct population segment (western population) of Steller sea lions. An average of 8.4 Steller sea lions from the western population was estimated to have been taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). The ratio of observed takes of Steller sea lions to observed groundfish catch (from 1995 to 1999) was multiplied by the new projected groundfish catch (all fisheries combined) to estimate incidental takes expected to occur over the next six years under this FMP. The estimated annual incidental take of Steller sea lions under FMP 2.1 in all areas combined is expected to be less than 14 based on expected catch under FMP 2.1, or about one sea lion per 220,000 mt of groundfish harvested.

The MMPA requires NOAA Fisheries (NMFS Office of Protected Resources) to assess whether human-caused mortality threatens the stability or recovery of any species of marine mammal. The MMPA defines a measurement tool for this purpose, the PBR, that is a calculated value of the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. This calculation takes into consideration the most recent population estimates, historic population trends, status of the stock in relation to historic levels (i.e., whether it is depressed or not), and potential rates of recovery. According to the most recent stock assessment, PBR for the western population of Steller sea lions is 208 animals per year (Angliss and Lodge 2002). Mortality from incidental take and entanglement in marine debris is likely to continue under FMP 2.1 at levels that are small (less than 10%) relative to PBR and is therefore considered insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

Changes in the fishing mortality rate for Steller sea lion prey species were calculated using output from the targeted species model which projected catch rates for the various FMPs. The estimated fishing mortality rates expected to occur under each FMP were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining the effects on marine mammal populations. The baseline fishing mortality rates for the individual BSAI and GOA groundfish fisheries, the fishing mortality rates projected to occur under each FMP, and the relative difference between the baseline and alternative fishing mortality rates are shown in Table 4.5-61.

Under FMP 2.1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 140 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key Steller sea lion prey species is rated significantly adverse. It is worth noting that the harvest rate of pollock in the EBS was particularly low in 2002. Due to the high abundance of EBS pollock in recent years, model predictions project a decreased pollock catch corresponding with an increasing F in subsequent years under FMP 2.1. The harvest of EBS pollock under FMP 2.1 meets the criteria of a significantly adverse impact to Steller sea lions.

The fishing mortality rate of GOA pollock is expected to increase by an average of 100 percent relative to the comparative baseline over the next five years under FMP 2.1. This change in F is significant at the population level for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. FMP 2.1 allows for the recommencement of an Aleutian Islands pollock fishery and would result in changes to the fishing mortality rate that would be rated as significantly adverse under the criteria established in Table 4.1-6.

Under FMP 2.1, the BSAI Pacific cod fishing mortality rate is expected to increase by 79 percent. This change is determined to be significantly adverse to Steller sea lions according to the criteria established in Table 4.1-6. Under FMP 2.1, the GOA Pacific cod fishing mortality rate is expected to increase by 64 percent. This change is determined to be significantly adverse to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with a 124 percent increase in F under FMP 2.1 relative to the baseline.

Little difference is expected relative to the baseline and among FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 2.1 is expected to result in population level effects that are, therefore, significantly adverse to Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal measures for Steller sea lions in FMP 1 (and retained throughout all of the FMPs) were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for Other Species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where Steller sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as “global controls.” Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the western population of Steller sea lions.

Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of environmental components other than with the objective to protect Steller sea lions are repealed. Opening up these areas reduces the protection of prey resources in nearshore areas which have been shown to be used by foraging Steller sea lions. Such openings could plausibly result in adverse impacts to Steller sea lions due to removal of fish in these areas where harvest did not occur under the baseline condition. Significantly higher harvest levels of Steller sea lion prey species are expected to result under FMP 2.1, which would increase the potential for competitive interactions with Steller sea lions in offshore foraging areas where Steller sea lion/fishery interactions are reduced through lower overall harvest limits under the baseline condition. Thus the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are determined to be significantly adverse to the western population of Steller sea lions.

Disturbance

FMP 2.1 repeals closure areas established for the protection of environmental components other than Steller sea lions such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Increased harvest levels expected to occur under FMP 2.1 may result in increased disturbance to Steller sea lions. Disturbance to Steller sea lions may increase due to the increase in the amount of fishable area coupled with increases in TAC. The level of increased disturbance to Steller sea lions, though likely, cannot be estimated, and is therefore determined to result in conditionally significantly adverse effects if disturbance were to increase to a level where population level effects would be a likely result.

Cumulative Effects

The past/present effects on the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above (Table 4.6-5). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.6-1).

Mortality

- **Direct/Indirect Effects.** The estimated annual incidental take of Steller sea lions under FMP 2.1 in all areas of the BSAI and GOA combined is expected to be less than 14 based on expected catch under this FMP. Therefore, mortality from incidental take and entanglement in marine debris under FMP 2.1 is considered insignificant.

- **Persistent Past Effects.** Substantial mortality of Steller sea lions did not occur in the fisheries until after the 1950s. The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period are not complete (Perez and Loughlin 1991). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996 to 2000. The number of Steller sea lions incidentally taken in state-managed nearshore salmon gillnet fisheries and halibut longline fisheries is estimated at 14.5 sea lions per year in the PWS drift gillnet fisheries (Wynne *et al.* 1992). It is thought that shooting used to be a significant source of mortality prior listing the Steller sea lion as endangered under the ESA. Two cases of illegal shooting were prosecuted in the Kodiak area in 1998 involving two Steller sea lions from the western stock (Angliss *et al.* 2001). The subsistence harvest of the western population has decreased over the last ten years from 547 to 171 animals per year (1992-1998) (Angliss and Lodge 2002). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). Predation by transient killer whales and sharks has always contributed to the natural mortality of Steller sea lions but the numbers of sea lions taken and the relative contribution of this factor to the recent population decline and lack of recovery is currently under investigation (Matkin *et al.* 2001, Matkin *et al.* 2003, Springer *et al.* 2003).

- **Reasonable Foreseeable Future Effects.** Incidental take in the State-managed fisheries such as salmon gillnet fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely be relatively low (fewer than 10 per year). Entanglement in fishing gear and intentional shootings would also be expected to continue at a level similar to the baseline condition. Predation will continue to contribute to natural mortality but climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Effects of mortality are based on the contribution of the internal effects of the groundfish fishery and external mortality. These effects are considered significantly adverse since the overall human-caused mortality exceeds the PBR for this population and the species is listed as endangered under the ESA due to the severe decline of the species. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and, under the baseline conditions, has been considered to not cause jeopardy under the ESA (NMFS 2001a).

<u>Prey Availability</u>

- **Direct/Indirect Effects.** The combined harvest of Steller sea lion prey species under FMP 2.1 is expected to result in significantly adverse population level effects to Steller sea lions.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State waters, and partial overlap with other State-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries, perhaps in conjunction with climate and oceanographic fluctuations, greatly reduced the availability of forage fish to Steller sea lions. NMFS issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of Steller sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. The most recent BiOp and EIS (NMFS 2001b and 2001c) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline conditions. New fisheries in State or Federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects of availability of prey but the direction or magnitude of these changes is difficult to predict. Climate-induced change has been suspected in the decline of the western population Steller sea lion.

- **Cumulative Effects.** Effects on prey availability were found to be cumulative based on both internal and external effects on prey. Based on significantly adverse internal effects on prey availability under this FMP, when added to the past effects from foreign, JV, and domestic groundfish fisheries, and the state-managed salmon and herring fisheries, the cumulative effect is considered significantly adverse.

Spatial/Temporal Effects of Harvest

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of other environmental components would be reopened to fishing. Therefore, the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are determined to be significantly adverse to the western population of Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of the Steller sea lion protection measures, which remain in effect under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** The only reasonably foreseeable future factors external to the groundfish fisheries that affect the spatial/temporal harvest of Steller sea lion prey would be the state-managed salmon and herring fisheries, which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed in a similar manner to recent years. No new state or federal fisheries are anticipated at this time.

- **Cumulative Effects.** Effects of the spatial/temporal harvest of prey were based on both internal effects of the FMP, external effects of the groundfish fishery, and state-managed fisheries and future fisheries. The cumulative effect is considered significantly adverse based on the significantly adverse internal effects of FMP 2.1 on spatial temporal harvest of prey with the additional external effects.

Disturbance

- **Direct/Indirect Effects.** Although increased disturbance to Steller sea lions is likely, the level of that disturbance cannot be estimated and therefore, results in conditionally significant adverse effects; conditional on whether disturbance would result in population level effects.

- **Persistent Past Effects.** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI and GOA and state-managed fisheries. Past disturbances were also identified from commercial harvest, intentional shooting and subsistence harvest. General vessel traffic and disturbance to prey fields from gear have also regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future disturbance was identified for state-managed salmon and herring fisheries as well as general fishing and non-fishing vessel traffic in Steller Sea lion foraging areas. Subsistence harvest was also identified as a continuing source of disturbance to Steller sea lions. Levels of external disturbance are expected to be similar to baseline conditions.

- **Cumulative Effects.** Disturbance to Steller sea lions is from both internal and external effects and is considered conditionally significant adverse. This determination is conditional on the actual location and timing of additional disturbance and whether it could increase over baseline conditions to a level where population-level effects occur.

Direct/Indirect Effects FMP 2.2

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under FMP 2.1 and are considered insignificant.

Fisheries Harvest of Prey Species

Under FMP 2.2, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 69 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of this key Steller sea lion prey species is rated significant. Please see the discussion regarding the unusually low fishing mortality rate in 2002 (which served as the comparative baseline) in Section 4.5.8.1. The harvest of EBS pollock under FMP 2.2 management regime meets the criteria of a significantly adverse impact to Steller sea lions.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 13 percent under FMP 2.2. This change in F is insignificant under the FMP 2.2 scenario at the population level for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there is no directed Aleutian Islands pollock fishery under the baseline condition. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 2.2 and therefore effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level.

Under FMP 2.2, the BSAI Pacific cod fishing mortality rate is expected to increase by 28 percent which is considered significantly adverse to Steller sea lions according to the criteria established in Table 4.6-1. The GOA Pacific cod fishing mortality rate is expected to increase by 19 percent under the FMP 2.2 scenario which was determined to be insignificant to Steller sea lions at the population-level. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with a 64 percent increase in F under alternative FMP 2.2 relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions.

Ratings for harvest of individual prey species range from insignificant to significantly adverse. The combined harvest of Steller sea lion prey species under FMP 2.2 is rated significantly adverse overall (Table 4.6-5) as there are more prey species that will be adversely affected than those that will not and the overall effect on prey is likely to have population-level effects on the western population of Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 2.2 are rated insignificant to Steller sea lions as they do not deviate from the spatial/temporal measures under the baseline conditions.

Disturbance

FMP 2.2 retains the area closures contained in the comparative baseline. Disturbance of Steller sea lions under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore rated insignificant.

Cumulative Effects

The past/present effects on the western population of Steller sea lions are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.2 are described above (Table 4.6-5). The effects considered in this analysis are listed in Table 4.6-5. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Effects of incidental take and entanglement under FMP 2.2 for the western population of the Steller sea lion are insignificant as discussed under FMP 2.1.

- **Persistent Past Effects.** Persistent past effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of mortality on the western population of the Steller sea lion are significantly adverse as described under FMP 2.1.

Prey Availability

- **Direct/Indirect Effects.** Effects on prey availability under FMP 2.2 for the western population of the Steller sea lion would be significantly adverse as discussed under FMP 2.1.

- **Persistent Past Effects.** Persistent past effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of prey availability on the western population of the Steller sea lion are significantly adverse as described under FMP 2.1.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey is based on past and future effects of the groundfish fisheries and State-managed fisheries and is considered conditionally significant adverse. Although there are several hypotheses regarding the decline and lack of recovery of Steller sea lions, localized depletion of prey due to commercial fishing is a plausible mechanism for population level effects. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine to cause localized depletion of prey in key areas such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance to Steller sea lions both internal and external effects is considered insignificant because it is similar to the baseline condition, and population-level effects are unlikely.

4.6.8.2 Eastern Distinct Population Segment of Steller Sea Lions

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 2.1 is not likely to result in significant changes to the population trajectory of the eastern distinct population segment (eastern population) of Steller sea lions. No Steller sea lions from the eastern population have been taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). In this context, incidental take refers to animals which are deceased or have injuries that are expected to result in the death of the animal. Because no animals from the eastern population have been taken incidental to groundfish fisheries under the baseline conditions, increases in fishing effort under FMP 2.1 are not expected to result in a substantial increase in the level of incidental takes.

Entanglement of Steller sea lions from the eastern population in derelict fishing gear or other materials seems to occur at frequencies that do not have significant effects upon or represent a significant threat to the population. In conclusion, incidental take and entanglement in marine debris under FMP 2.1 are expected to be similar to the baseline conditions and are considered insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

The BSAI groundfish fisheries are not likely to have large impacts on prey availability for the eastern population of Steller sea lions as there is little overlap between this population and fisheries that harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to have an effect on the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock and Pacific cod under FMP 2.1 are expected to increase by 100 percent and 64 percent, respectively, relative to the comparative baseline over the next five years. The changes in the fishing mortality rates expected to occur under FMP 2.1 are rated significantly adverse at the population level for the eastern population of Steller sea lions.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species in the GOA under FMP 2.1 is expected to result in significantly adverse population level effects on the eastern population of Steller sea lions (Table 4.6-5).

Spatial/Temporal Concentration of the Fishery

The criteria used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations assume that the FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population level effects would occur. The spatial/temporal measures under the baseline conditions were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Under the baseline condition, groundfish fisheries have been dispersed in time and space such that the competitive interactions with Steller sea lions are thought to be mitigated to an insignificant level. Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of environmental components other than Steller sea lions are repealed. Opening up these areas reduces the protection of prey resources in nearshore areas that have been shown to be used by foraging Steller sea lions and could plausibly result in adverse impacts to Steller sea lions due to removal of fish in these areas where harvest did not occur under the baseline condition. Thus, the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are determined to be conditionally significant adverse to Steller sea lions, contingent on the actual concentration of the fisheries reducing prey to a level that results in a population-level effect.

Disturbance

FMP 2.1 repeals closure areas established for the protection of environmental components other than Steller sea lions such as the Pribiliof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. The area that is of specific concern for the eastern population of Steller sea lions under FMP 2.1 is the trawl exclusion zone in the eastern GOA which would be open to trawling under this FMP. Disturbance of the eastern population of Steller sea lions is expected to increase under the FMP 2.1 management regime if trawling activity occurs in this previously closed area. Catch of fishery target species is also projected to increase under FMP 2.1 relative to the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase above the baseline conditions to the level that population level effects could occur and is therefore determined to be conditionally significant adverse to the eastern population of Steller sea lions.

Cumulative Effects

The past/present effects on the eastern population of the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1are described above (Table 4.6-5). The effects considered in this analysis are listed in Table 4.6-5. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.6-1).

<u>Mortality</u>

- **Direct/Indirect Effect.** With regard to incidental take and entanglement, FMP 2.1 is not likely to result in significant changes to the population trajectory of the eastern population of Steller sea lions, and is therefore considered insignificant.

- **Persistent Past Effects.** It is thought that shooting used to be a significant source of mortality prior to listing the Steller sea lion as "threatened" under the ESA. NMFS Alaska Enforcement Division has successfully prosecuted two cases of illegal shooting involving four sea lions from the eastern population (Angliss *et al.* 2001). It is not known to what extent illegal shooting continues in the eastern population but stranding of sea lions with bullet holes still occurs. Predator control programs associated with mariculture facilities in British Columbia account for a mean of 44 animals killed per year from the eastern population (Angliss and Lodge 2002). The subsistence harvest of the eastern population is subject to an average of only two sea lions taken per year from southeast Alaska (1992 to 1997) (Angliss *et al.* 2001). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). The proportion of these from the eastern population of Steller sea lions is unknown. Intentional shooting of Steller sea lions, other than in subsistence hunts, became illegal after the species was listed as threatened under the ESA in 1990. It is thought that shooting was a significant source of mortality prior to that time. Steller sea lions are incidentally taken in low numbers by commercial fisheries other than groundfish fisheries, including some state-managed salmon drift and set gillnet fisheries, and the salmon troll fishery in southeast Alaska (mean of 1.25 and 0.2 respectively) (Angliss and Lodge 2002). Small numbers of Steller sea lions from the eastern population are also taken outside of southeast Alaska in groundfish fisheries (0.45 per year in Washington, Oregon, and California) and set gillnet fisheries in Northern Washington state (0.2 per year) (Angliss and Lodge 2002). The PBR for this population is 1,396 and current human caused mortality is 45.5, substantially less than 10 percent of the PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillnet and troll fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely be relatively low (<10 per year). Groundfish fisheries in Washington, Oregon and California and salmon set gillnet fisheries will continue to take small numbers from this population. Entanglement and intentional shootings would also be expected to continue. Pollution is likely more of a factor for this population due to its proximity to human population centers. Climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Effects of mortality are based on the contribution of internal effect of the groundfish fishery and external mortality effects. These effects are considered insignificant since the overall human-caused mortality does not exceed the PBR for this population. Although this population is listed as threatened under the ESA, this population has been increasing over the last 20 years. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and has been determined to not cause jeopardy under the ESA (NMFS 2001a).

Effects of Prey Availability

- **Direct/Indirect Effect.** Due to major increases in the projected harvest of target and non-target species under FMP 2.1, the effect on prey availability was determined to be significantly adverse to Steller sea lions.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in state waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a similar manner to the baseline condition. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects on availability of prey but the direction or magnitude of these changes is difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion, but effects of climate change or regime shifts on the eastern population of the Steller sea lion are largely unknown.

- **Cumulative Effects.** Effects on prey availability were found to be cumulative based on both internal and external effects on prey. The significantly adverse contribution of the groundfish fishery under FMP 2.1 may or may not lead to adverse population level effects, conditional on whether future food availability limits population growth. The cumulative effect is thus considered conditionally significant adverse.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of other environmental components would be reopened to fishing. The effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are determined to be conditionally significant adverse to the eastern population of Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring.

Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of the Steller sea lion protection measures, which remain in effect under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** The only reasonably foreseeable future factors external to the groundfish fisheries that affect the spatial/temporal harvest of Steller sea lion prey would be the state-managed salmon and herring fisheries, which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed in a similar manner to recent years. No new state or federal fisheries are anticipated at this time.

- **Cumulative Effects.** Cumulative effects of the spatial/temporal harvest of prey from both internal effects of the groundfish fishery and state-managed fisheries would be substantially greater than the baseline condition and are considered conditionally significant adverse. This rating is conditional on whether the combined spatial/temporal patterns of prey removal from all fisheries in the range of the eastern population of Steller sea lions actually creates localized depletion of prey such that adverse population level effects occur.

<u>Disturbance</u>

- **Direct/Indirect Effects.** Disturbance of Steller sea lions under FMP 2.1 may increase substantially above the baseline conditions and is therefore determined to be conditionally significant adverse. This rating is conditional on whether changes in disturbance patterns would actually result in population level effects.

- **Persistent Past Effects.** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI and GOA and State-managed fisheries. Past disturbances were also identified from commercial harvest, intentional shooting and subsistence harvest. General vessel traffic and disturbance to prey fields from gear have also regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future disturbance was identified for state-managed salmon and herring fisheries as well as general fishing and non-fishing vessel traffic in Steller Sea lion foraging areas. Subsistence harvest was also identified as a continuing source of disturbance to Steller sea lions. Levels of external disturbance are expected to be similar to baseline conditions.

- **Cumulative Effects.** The cumulative effects of disturbance to the eastern population of Steller sea lions from both internal and external effects are considered conditionally significant adverse, conditional on location and time period of additional disturbance and whether it would result in population-level effects.

Direct/Indirect Effects FMP 2.2

<u>Incidental Take/Entanglement in Marine Debris</u>

Effects do not deviate from those described under FMP 2.1 and are considered insignificant.

Fisheries Harvest of Prey Species

Average fishing mortality rates of GOA pollock under FMP 2.2 are expected to decrease by 13 percent relative to the comparative baseline over the next five years. Average fishing mortality rates of GOA Pacific cod under FMP 2.2 are expected to increase by 19 percent relative to the comparative baseline over the next five years. The changes in the fishing mortality rates expected to occur under FMP 2.2 are insignificant relative to the baseline for GOA pollock and Pacific cod harvests.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 2.2 is expected to be similar to the baseline condition and to insignificant effects on the eastern population of Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant to Steller sea lions as they do not deviate from the spatial/temporal measures under the baseline condition.

Disturbance

FMP 2.2 retains the area closures set forth under the baseline. Disturbance of Steller sea lions under the 2.2 management regime is not expected to increase relative to the baseline and is therefore rated insignificant.

Cumulative Effects

The past/present effects on the eastern population of Steller sea lions in southeast Alaska are described in Section 3.8.1 (Table 3.8-1). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Effects of incidental take and entanglement under FMP 2.2 for the eastern population of the Steller sea lion would be insignificant.
- **Persistent Past Effects.** Persistent past effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.
- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.
- **Cumulative Effects.** The cumulative effect of mortality on the eastern population of the Steller sea lion would be insignificant, as described under FMP 2.1.

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of Steller sea lion prey species under FMP 2.2 is expected to result in insignificant population-level effects on Steller sea lions.

- **Persistent Past Effects.** Persistent past effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** Effects on prey availability are based on both internal and external effects on prey but since the eastern population has been increasing over the last 20 years, the availability of prey is not considered a major issue with this population. The cumulative effects are not expected to result in population-level effects and are considered insignificant for this population in southeast Alaska.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** Cumulative effects of the spatial/temporal concentration of harvest of prey from internal past effects of the groundfish fishery and state-managed fisheries are likely to remain similar to the baseline condition, under which the eastern population has increased steadily, and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance to Steller sea lions from both internal and external effects is considered insignificant because it is similar to the baseline condition, and population-level effects are unlikely.

4.6.8.3 Northern Fur Seals

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, takes and entanglements of northern fur seals expected to occur incidental to groundfish fisheries under FMP 2.1 are not expected to result in population level effects. Increased harvest rates under this management alternative are not large enough for expected take levels to increase relative to the baseline. Therefore, this effect is expected to be insignificant under FMP 2.1.

Fisheries Harvest of Prey Species

Under FMP 2.1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 140 percent relative to the comparative baseline. This change in the harvest of adult pollock, which is a key prey species of northern fur seals in the EBS, is rated significantly adverse. Various nearshore areas that were closed under the baseline conditions would be repealed in FMP 2.1. Opening these nearshore areas could potentially result in a shift in the species and age composition of groundfish harvests such that prey species of northern fur seals would be more susceptible to harvest under this management regime relative to the baseline conditions. Therefore, the harvest of northern fur seal prey species was determined to be conditionally significant adverse. Population level effects are plausible but the rating is conditional on whether the increased level of pollock harvest under FMP 2.1 results in limited prey resources and if the fishery further encroaches into nearshore fur seal foraging areas in the groundfish fisheries.

Spatial/Temporal Concentration of the Fishery

The criterion used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations is that the alternative FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population level effects would be expected to occur. Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of environmental components other than Steller sea lions are repealed. Opening these areas to fishing may reduce the protection of prey resources in nearshore areas that have been shown to be used by foraging northern fur seals and could plausibly result in adverse impacts to northern fur seals due to removal of fish in these areas where harvest did not occur under the baseline conditions. FMP 2.1 is less precautionary for northern fur seals as areas such as the Pribilof Habitat Conservation area would be open to fishing. The effect on northern fur seals of fishing in these areas that were closed under the baseline is unknown. In addition to an overall projected increase in harvest of adult pollock under FMP 2.1, harvest of juvenile target species that are a large portion of the northern fur seal diet may increase if fisheries were to move into these nearshore areas. Such harvests are likely to have a greater effect on the species than harvest under the baseline conditions. Thus the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are rated conditionally significantly adverse to northern fur seals. The rating is conditional based on whether repeal of baseline protection measures actually increases concentration of harvest in fur seal foraging areas and such harvest has population-level effects.

Disturbance

The potential for disturbance effects caused by vessel traffic, fishing gear or noise appears limited for northern fur seals. Kajimura (1984) (in Johnson *et al.* 1989) reported no response by fur seals when approached by ships, and NOAA Fisheries observers onboard Japanese driftnet vessels regularly reported fur seals in close proximity to both the gear and fishing vessels (INPFC reports from the 1980s). Interactions with other types of fishing gear, such as trawl nets, also appear to be limited, based on the rare incidence of takes in groundfish fisheries and limited overlap between northern fur seal prey preferences and fisheries targets.

The FMP 2.1 bookend repeals closure areas established for the protection of environmental components other than Steller sea lions such as the Pribiliof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Disturbance of northern fur seals is expected to increase under the FMP 2.1 management regime if trawling activity occurs in this previously closed area. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to the level that population level effects could occur and is, therefore, determined to be conditionally significant adverse to northern fur seals. The rating is conditional based on whether disturbance increases substantially around fur seal rookeries in the Pribilof Islands and whether it actually causes population-level effects.

Cumulative Effects

A summary of the effects of the past/present with regards to the northern fur seal is presented in Section 3.8.2. (Table 3.8-2). The predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above (Table 4.6-5). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries (Table 4.6-5).

Mortality

- **Direct/Indirect Effects.** Under FMP 2.1, effects of incidental take and entanglement are not expected to have population-level effects and are considered insignificant.

- **Persistent Past Effects.** Effects of past mortality on fur seal population include commercial harvest of young males up to 1985, harvest of females between 1956 and 1968, incidental take in the JV fisheries, foreign fisheries, and annual subsistence harvest on the Pribilof Islands. Commercial harvest of fur seals peaked in 1961 with over 126,000 animals but was halted in 1985. The harvest of female fur seal on the Pribilof Islands, as many as 300,000 between 1956 and 1968, likely contributed to the decline of the population in the late 1970s and early 1980s (York and Kozloff 1987). This precipitous decline resulted in its depleted status under the MMPA. Entanglements may have contributed significantly to declining trends of the population during the late 1970's (Fowler 1987). Since the cessation of commercial harvest in 1985, fur seal number have steadily declined (NMFS 1993, Angliss and Lodge 2002). The contribution of the earlier harvest of fur seal to the subsequent declines uncertain since it has been nearly 20 years since commercial harvest was ended. Subsistence harvest have been one of the major contributors to fur seal mortality in recent years. From 1986 to 1996, the average annual subsistence take was 1,605 from St. Paul and St. George

Islands. From 1995 to 2000 this average take dropped to 1,340 seals per year, which represents about 8 percent of the PBR for this species.

- **Reasonably Foreseeable Future External Effects.** These effects include incidental take from foreign fisheries outside the EEZ where fur seals are widely dispersed. State-managed fisheries take small numbers of fur seal including the PWS drift gillnet fishery, Alaska Peninsula and Aleutian Island salmon gillnet fisheries, and the Bristol Bay salmon fisheries (Angliss and Lodge 2002). Subsistence will continue to be a major source of mortality in the future but is limited to the Pribilof Islands, but levels of take are expected to be well below 10 percent of the PBR for this species.

- **Cumulative Effects.** The cumulative effects of mortality from internal and external factors are considered insignificant because the expected levels of take for fur seals would be well below the PBR of this species. The contribution of the groundfish fisheries is very small and approaches zero. Thus, population level effects are not anticipated.

Availability of Prey

- **Direct/Indirect Effects.** The effects of the groundfish fisheries under FMP 2.1 include a substantial increase in the removal of northern fur seal forage. The overall harvest of northern fur seal prey species is rated as conditionally significant adverse.

- **Persistent Past Effects.** Effects of groundfish harvest in the past have likely occurred from overlap of prey species and fish targeted by the foreign and JV fisheries in the BSAI as well as by the State and Federal fisheries. Climate and oceanic fluctuations are also suspected in past changes in the abundance and distribution of prey.

- **Reasonably Foreseeable Future External Effects.** Effects on prey availability for northern fur seal in the future are anticipated to come from a small overlap in prey species with the State-managed salmon and herring fisheries in nearshore areas and effects of climate change/regime shifts on prey species abundance and distribution. Climate effects are largely unknown but could potentially have adverse effects on the availability of prey.

- **Cumulative Effects.** The cumulative effect of prey availability from both the internal contribution of the groundfish fisheries and external effects on prey such as other fisheries and possibly long-term climate change is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Spatial/Temporal Concentration of Harvest

- **Direct/Indirect Effect.** Effects of groundfish fisheries under FMP 2.1 on the spatial/temporal concentration of fisheries harvest are a substantial departure from the baseline conditions and are thus determined to be conditionally significant adverse.

- **Persistent Past Effect.** Effects of past fisheries harvest on prey are primarily from the foreign and JV fisheries and the BSAI state and federal domestic fisheries. There has been concern with regard to displaced/increased fishing effort that encroaches into nearshore areas of the Pribilof Islands and results in increased overlap with fur seal foraging areas. After adoption of measures designed to protect Steller sea lions, the proportion of the total June-October pollock catch in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is particular concern for the potential impact of this increased fishing pressure on lactating females from St George Island where catch rates were consistently higher than in areas used by females from St. Paul (Robson *et al.* 2004).

- **Reasonably Foreseeable Future External Effects.** Effects of the spatial/temporal harvest of prey species is primarily from the foreign and Federal domestic fisheries outside the EEZ, due to the extensive range of the fur seals when they are away from their breeding rookeries. State-managed fisheries have very limited overlap with fur seal prey. Climate change was also identified as a potential factor in spatial/temporal effects on prey.

- **Cumulative Effects.** The cumulative effects of the spatial/temporal harvest of prey resulting from internal and external sources are considered conditionally significant adverse. This rating is based on the substantial decline in northern fur seal populations and is conditional on the actual contribution that the harvest of prey species plays in this declining trend.

<u>Disturbance</u>

- **Direct/Indirect Effects.** Levels of disturbance are expected to be substantially greater than those which occurred to northern fur seals under the baseline conditions and could potentially have population-level effects that are expected to be conditionally significant adverse.

- **Persistent Past Effects.** Past disturbance of fur seals includes commercial groundfish fisheries harvest by JV fisheries, foreign and federal domestic fisheries, state-managed fisheries and, to a lesser extent, the subsistence harvest of fur seal on the Pribilof Islands. It is unlikely that disturbance persists as a result of these past activities but the ongoing fisheries do continue to result in some level of disturbance to fur seal while they are in the BSAI region.

- **Reasonablely Foreseeable Future Effects.** Disturbance effects on fur seal were identified from state-managed fisheries, general vessel traffic, and subsistence activities on the Pribilof Islands.

- **Cumulative Effects.** The cumulative effects of disturbance were determined to be conditionally significant adverse based on the conditionally significant internal effects of the fisheries when added to the external human-caused disturbance. This rating is conditional on the increased disturbance occurring in foraging areas important to fur seals and having a population level effect.

Direct/Indirect Effects FMP 2.2

<u>Incidental Take/Entanglement in Marine Debris</u>

Effects do not deviate from those described under FMP 2.1.

Fisheries Harvest of Prey Species

Under FMP 2.2 , the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 69 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, this change in the harvest of adult pollock, which is a key prey species of northern fur seals in the EBS, is rated significantly adverse. Overall, the harvest of northern fur seal prey species was determined to be conditionally significant adverse as population level effects are plausible but the rating is conditional on whether the increased level of pollock harvest projected under FMP 2.2 results in limited prey resources such that fur seals are impacted at the population level.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant to northern fur seals as they do not deviate from the spatial/temporal measures under the baseline conditions. However, effects to northern fur seals from spatial/temporal concentration of the fisheries under the strategy defined as the baseline for this environmental analysis were rated conditionally significant adverse in the Steller sea lion SEIS (NMFS 2001b). Therefore, while the spatial/temporal effects of FMP 2.2 are insignificant relative to the baseline, the baseline has been described as having potential adverse effects on northern fur seals.

Disturbance

Disturbance of northern fur seals under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore considered insignificant.

Cumulative Effects

The past/present effects on the northern fur seal are described in Section 3.8.2 (Table 3.8-2). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6). See Table 4.6-5 for a summary of the cumulative effects under FMP 2.2.

Mortality

- **Direct/Indirect Effects.** Under FMP 2.2, effects of incidental take and entanglement are not expected to have population-level effects and are considered insignificant.

- **Persistent Past Effects.** Persistent past effects on northern fur seals are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on northern fur seals are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of mortality from internal and external factors are considered insignificant because the expected levels of take for fur seals would be below the PBR of this species. The contribution of the groundfish fisheries is very small and approaches zero. Thus, population level effects are not anticipated.

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of northen fur seal prey species under FMP 2.2 is expected to result in conditionally significant adverse population-level effects on northern fur seal.

- **Persistent Past Effects.** Persistent past effects on the northern fur seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the northern fur seal are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of prey availability from the internal contribution of the groundfish fisheries and external effects on prey from other fisheries and possibly long-term climate change are conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the northern fur seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the northern fur seal are the same as described under FMP 2.1.

- **Cumulative Effects.** Cumulative effects of the spatial/temporal harvest of prey from internal and external sources are conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the northern fur seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the northern fur seal are the same as described under FMP 2.1.

- **Cumulative Effects.** Cumulative effects of disturbance to northern fur seals from both internal and external effects are considered insignificant because these effects are similar to the baseline condition and population-level effects are unlikely.

4.6.8.4 Harbor Seals

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, incidental takes and entanglements of harbor seals expected to occur incidental to groundfish fisheries under FMP 2.1 are not expected to result in population level effects. Increased harvest rates under this management alternative may result in the increased take of 2 harbor seals relative to the baseline, for a total estimated average of fewer than 7 animals per year. This level of incidental take would not result in changes to the population trajectory for this species. Therefore, takes and entanglements of harbor seals incidental to groundfish fisheries are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Under FMP 2.1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 140 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of this key harbor seal prey species is considered to be significant. See the discussion regarding the unusually low fishing mortality rate of EBS pollock in 2002 in Section 4.5.8.1. The harvest of EBS pollock under the FMP 2.1 management regime meets the criteria of a significantly adverse impact to harbor seals.

The fishing mortality rate of GOA pollock is expected to increase by an average of 100 percent under FMP 2.1 relative to the comparative baseline over the next 5 years. The change in F is significant at the population level for harbor seals under the 2.1 scenario. Under Alternative bookend 2.1, the BSAI Pacific cod fishing mortality rate is expected to increase by 79 percent, which is determined to be significantly adverse to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under FMP 2.1 are expected to be significantly adverse to harbor seals with a 124 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for harbor seals (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to harbor seals. The combined harvest of harbor seal prey species under FMP 2.1 is expected to be substantially above the baseline level and thus result in significantly adverse population level effects.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of environmental components other than Steller sea lions would be repealed. Spatial partitioning of offshore commercial harvests from the Steller sea lion conservation measures and inshore feeding harbor seals is likely to limit the degree of potential competition with fisheries, although the foraging range of harbor seals may still overlap commercial fishing grounds. Such overlaps exist in regard to the western and GOA harbor seal stocks whereas the southeast Alaska stock of harbor seals overlaps little with federally managed commercial groundfish fisheries (Ferrero *et al.* 2000). However, repealing trawl closure areas in southeast Alaska would be expected to result in increased overlap between groundfish fisheries and the southeast Alaska harbor seal stock. Opening up these areas reduces the protection of prey resources in nearshore areas that have been shown to be used by foraging harbor seals and could plausibly result in adverse impacts to harbor seals due to removal of fish in these areas where harvest did not occur under the baseline conditions. Thus the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are rated conditionally significantly adverse to harbor seals.

Disturbance

Disturbance of harbor seals is expected to increase under the FMP 2.1 management regime if trawling activity occurs in previously closed areas. Catch of fishery target species is also projected to increase under FMP 2.1 relative to the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to the level that population-level effects could occur and is determined to be conditionally significant adverse to harbor seals.

Cumulative Effects

A summary of the effects of the past/present with regards to the harbor seal is presented in Section 3.8.4. (Table 3.8-4). The predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above (Table 4.6-5). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Takes and entanglements of harbor seals expected to occur incidental to groundfish fisheries under FMP 2.1 are not expected to result in population level effects, and therefore are considered to be insignificant.

- **Persistent Past Effect.** Residual effect on local populations of State predator control programs (1950s to 1972) and commercial hunts (1963 to 1972) may still occur in some areas although there are no data on these factors. Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear, but based on the near shore distribution of harbor seals, there was likely minimal direct interaction, and mortality is believed to have been very low. From 1990 to 1996, minimum estimates of harbor seals taken incidentally in groundfish gear in the Bering Sea were 4 per year and fewer than 1 per year in the GOA. In southeast Alaska, 4 harbors seals are estimated to be killed each year on longlines. Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide subsistence harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which were taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). Subsistence harvest of Bering sea stock of harbor seals is approximately 161 animals, 42 percent of PBR for this species. For the GOA stock, the harvest is at approximately 91 percent of the PBR for this stock. For the southeast stock, harvest is at approximately 83 percent of PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take of harbor seal in state-managed fisheries such as salmon gillnet fisheries would be expected to continue at its present low rate. Subsistence take is expected to continue to be the greatest source of human-controlled mortality with a relatively high percentage of the PBR in both the GOA and southeast Alaska stock and a lower take in the BSAI region. Climate change is likely not a factor in the direct mortality of harbor seal although there would likely indirect effects.

- **Cumulative Effects.** The cumulative effects of mortality were determined to be insignificant since the combined contribution between the various sources would continue to be under the PBR for this species.

Availability of Prey

- **Direct/Indirect Effects.** The combined harvest of harbor seal prey species under FMP 2.1 is expected to be much greater than the baseline level and result in significantly adverse effects on prey availability.

- **Persistent Past Effects.** Availability of prey for harbor seal in the past has likely been affected by foreign and JV fisheries, federal domestic groundfish fisheries and state-managed salmon and herring fisheries since the fish targeted by these fisheries are also prey of the harbor seal. Climate change/regime shift could possibly have been a factor in fluctuations in prey availability in the past.

- **Reasonably Foreseeable Future External Effects.** State-managed salmon and herring fisheries are identified as potential adverse effects on harbor seal prey availability. Climate change/regime shift will continued to be a contributing factor although the effects can be either beneficial or adverse, depending on direction and magnitude of the change.

- **Cumulative Effects.** The cumulative effect on prey availability was determined to be significantly adverse based on a significant internal effect and the additional contribution of external effects and is likely to have a population-level effect on harbor seals.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are rated conditionally significantly adverse to harbor seals.

- **Persistent Past Effects.** Effect of groundfish harvest in the past has likely occurred from overlap of harbor seal prey species and fish targeted and areas fished by the foreign and JV fisheries in the BSAI as well as the State and Federal fisheries.

- **Reasonably Foreseeable Future External Effects.** Future effect on spatial/temporal harvest is considered to come from the competitive overlap in prey species with the state-managed fisheries in nearshore areas such as salmon and herring and from climate change/regime shifts on prey species abundance and distribution. Since these fisheries generally occur in the nearshore areas in comparsion to groundfish fisheries, overlap is more pronounced than with the groundfish fisheries.

- **Cumulative Effects.** A cumulative effect of spatial/temporal harvest of prey is identified and rated as conditionally significant adverse, based on the increased level of harvest of harbor seal prey species, fishing areas newly opened, contribution from state-managed fisheries, and conditional on prey being substantially less available and resulting in a population-level effect.

Disturbance

- **Direct/Indirect Effect.** Disturbance of animals under FMP 2.1 may increase to the level that population-level effects could occur and is determined to be conditionally significant adverse to harbor seals.

- **Persistent Past Effects.** Disturbance of harbor seals from past effects include commercial groundfish fisheries harvest by JV fisheries, foreign and federal domestic fisheries and to a lesser extent the subsistence harvest of harbor seals. It is unknown whether these past activities have persistent effects in the present but the ongoing fisheries activities and subsistence do continue to result in some level of disturbance to harbor seal.

- **Reasonablely Foreseeable Future Effects.** State-managed fisheries, general vessel traffic and subsistence activities would continue to create some level of disturbance to harbor seal in the foreseeable future.

- **Cumulative Effects.** A cumulative effect was identified for disturbance from contributions from internal sources and external factors such as other fisheries. However, since fishing effort would increase substantially under FMP 2.1, and the effects of this level of disturbance are not well understood, the cumulative effect on harbor seal is considered conditionally significant adverse, conditional on the actual locations and time period of this new disturbance.

Direct/Indirect Effects FMP 2.2

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under FMP 2.1 and are considered insignificant.

Fisheries Harvest of Prey Species

Under FMP 2.2 , the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 69 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key harbor seal prey species is rated significant. See the discussion regarding the unusually low fishing mortality rate in 2002 (which served as the comparative baseline) in Section 4.5.8.1. The harvest of EBS pollock under the FMP 2.2 management regime meets the criteria of a significantly adverse impact to harbor seals.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 13 percent under the FMP 2.2 bookend relative to the comparative baseline over the next 5 years. The change in F is insignificant at the population level for harbor seals under the FMP scenario. Under FMP 2.2, the BSAI Pacific cod fishing mortality rate is expected to increase by 28 percent, which is determined to be significantly adverse to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under the FMP 2.2 bookend are expected to be significantly adverse to harbor seals with a 64 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for harbor seals (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives was determined to be insignificant to harbor seals. The combined harvest of harbor seal prey species under FMP 2.2 is expected to be substantially greater than the baseline for some species but not for others, leading to a rating of conditionally significantly adverse effect on prey availability. This rating is conditional on whether harvest rates under FMP 2.2 actually deplete harbor seal prey availability to the point that population-level effects occur.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant to harbor seals as they do not deviate from the spatial/temporal measures under the baseline condition and are not likely to cause population level effects.

Disturbance

Disturbance of harbor seals under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore considered to be insignificant.

Cumulative Effects

The past/present effects on the harbor seal are described in Section 3.8.4 (Table 3.8-4). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Takes and entanglements of harbor seals expected to occur under FMP 2.2 are expected to be similar to the baseline level and are considered to be insignificant at the population level.

- **Persistent Past Effects.** Persistent past effects on the harbor seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the harbor seal are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of mortality were determined to be insignificant since the combined contribution between the various sources would continue to be under the PBR for this species.

<u>Prey Availability</u>

- **Direct/Indirect Effects.** The combined harvest of harbor seal prey species under FMP 2.2 is expected to result in conditionally significant adverse population-level effects on harbor seals.

- **Persistent Past Effects.** Persistent past effects on the harbor seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on harbor seal are same as described under FMP 2.1.

- **Cumulative Effects.** Effects on prey availability were found to be cumulative based on both internal and external effects on prey from other fisheries and possibly long-term climate change. This cumulative effect is considered conditionally significant adverse based on the internal effects of decreased availability of prey species. This rating is conditional on whether prey availability has played a role in the past population decline of harbor seals and whether future combined harvest rates actually deplete harbor seal prey availability to the point that population-level effects occur.

<u>Spatial/Temporal Concentrations of the Fisheries</u>

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are similar to the baseline and determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the harbor seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the harbor seal are the same as described under FMP 2.1.

- **Cumulative Effects.** Cumulative effects on spatial/temporal harvest of prey are rated as conditionally significant adverse based on the increased level of harvest of harbor seal prey species under FMP 2.2 plus a contribution from state-managed fisheries. This rating is conditional on whether past spatial/temporal patterns of prey harvest have played a role in the past population decline of harbor seals and whether future combined harvest patterns actually cause localized depletions of food to the point that population-level effects occur.

<u>Disturbance</u>

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the harbor seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on harbor seal are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance to harbor seal is found to be cumulative based on contributions from both internal and external effects. This effect was considered insignificant because it is similar to the baseline condition and population-level effects are unlikely.

4.6.8.5 Other Pinnipeds

FMP 2.1 – Direct/Indirect Effects

<u>Incidental Take/Entanglement in Marine Debris</u>

Due to the low level of documented interactions between other pinnipeds and groundfish fisheries (see section 4.5.8.5), takes and entanglements of other pinnipeds incidental to groundfish fisheries under FMP 2.1 are expected to be insignificant according to the criteria established in Table 4.1-6.

<u>Fisheries Harvest of Prey Species</u>

As stated under FMP 1, the effects of fisheries harvests on ice seal prey species are insignificant under the baseline due to limited overlap with the fisheries, and are not likely to change under any of the alternative regimes. The effects of fisheries harvest on prey species are determined to be insignificant to ice seals under FMP 2.1.

With regard to Pacific walrus, their diet is composed almost exclusively of benthic invertebrates (97 percent), particularly bivalve molluscs. Fish ingestion has been considered incidental to their normal feeding behavior (Fay and Stoker 1982). Groundfish removals would not have a significant effect on walrus populations.

The diet of northern elephant seals in the GOA is unknown; however, the species is known to be a deep diver. This behavior suggests that their foraging may be partitioned by depth from most groundfish fishing activities. The effects of groundfish harvests on prey species for northern elephant seals are determined to be unknown under all of the alternative FMPs.

<u>Spatial/Temporal Concentration of the Fishery</u>

Due to the limited potential for competitive overlap between pinnipeds included in this section and the groundfish fisheries, the spatial/temporal concentrations of the fisheries are expected to be insignificant to marine mammals in this category under all of the alternative FMP scenarios.

<u>Disturbance</u>

FMP 2.1 repeals area closures established for the protection of some of the species in the "other pinnipeds" category (e.g. walrus). The level of disturbance on pinnipeds is expected to increase under the 2.1 management regime. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to a level at which population level effects could occur, especially on walrus as groundfish fisheries would be permitted in the immediate vicinity

of important walrus habitat. The effect of disturbance is therefore rated conditionally significantly adverse for “other pinnipeds.”

Cumulative Effects

The past/present effects on “other pinnipeds” are described in Section 3.8.3 and Sections 3.8.5 through 3.8.9 (Tables 3.8-3 and 3.8-5 through 3.8-9) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1are described above. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Incidental take and entanglement under FMP 2.1 for species in the “other pinniped” category are considered insignificant.

- **Persistent Past Effects.** Past external effects on the populations of pinniped include low levels of incidental take in the foreign, JV, and domestic groundfish fisheries and low levels of take in the State-managed fisheries. Spotted seal incidental mortality in groundfish fisheries is one per year between 1995 and 1999 (Angliss *et al.* 2001). For bearded seal, the BSAI groundfish fisheries take an average of 0.6 per year. The Bristol Bay salmon drift gillnet fishery from 1990-1993 indicated that 14 mortalities and 31 injuries of bearded seal. No mortalities of ringed seal have been observed in the last ten years in the BSAI groundfish (Angliss *et al.* 2001). For ribbon seal incidental take, the Bering Sea trawl fishery took one in 1990, one in 1991, and one in 1997. An average of 86 elephant seals is taken each year in various gillnet fisheries from California to Washington. Incidental take included one in the Bering Sea trawl fishery reported in 1990, two in the GOA trawl fishery in 1990, and three in the GOA longline fishery in 1990. One juvenile elephant seal, originally misidentified as a bearded seal, was taken in the Bering Sea trawl fishery in 1991 (Angliss *et al.* 2001). Of the 17 Pacific walrus that were caught each year in groundfish trawl fisheries in the EBS between 1990 and 1997, over 80 percent were already decomposed (Gorbics *et al.* 1998). Subsistence is the major human-cause external factor for morality. Subsistence annual harvest rates include 5,265 spotted seal, 6,788 bearded seal, 100 ribbon seal, 9,567 ringed seal, 1,000 walrus and zero elephant seal.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries will likely continue to take very small numbers of seals in this group. Subsistence take of these marine mammals will likely continue at a similar rate to the baseline conditions.

- **Cumulative Effects.** Mortality within the other pinniped group was considered cumulative, based on both internal effects of the groundfish fisheries and external effects such as subsistence harvest. For spotted, ringed, bearded, and ribbon seals, PBRs cannot be calculated. Walrus take is below PBR and population level effects are unlikely. Elephant seal populations are expanding so overall mortality is considered insignificant. Contributions of the groundfish fisheries to overall mortality is very small.

Abundance of Prey

- **Direct/Indirect Effect.** Except for elephant seals, where the amount of prey overlap is unknown, there is very little overlap of species taken in the groundfish fisheries with prey of the pinnipeds in this group and the effects of fisheries harvest on prey species are determined to be insignificant under FMP 2.1.

- **Persistent Past Effects.** Past effects on spotted seal prey include foreign, JV, and domestic groundfish fisheries and State-managed fisheries for salmon and herring. For the ice seals, elephant seals and walrus, no persistent past effects were identified due to minimal overlap with commercial fisheries.

- **Reasonably Foreseeable Future External Effects.** Future effects on the spotted seal were identified from state-managed fisheries. Climate change may be either a beneficial factor or adverse factor for the ice seals, due to the potential effects on the extent of ice cover in the Bering Sea and effect on abundance and distribution of prey.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance of prey for pinnipeds is considered insignificant for all species. Spotted seals have some overlap of prey with the groundfish fisheries but the harvest of prey by the fisheries is not expected to have population level effects. The amount of groundfish fishery overlap with elephant seals is unknown but, since the elephant seal population is expanding, food does not appear to be limiting so cumulative effects on prey availability are considered insignificant. The amount of prey overlap with the other pinniped species is very limited and is considered insignificant for all species in this group.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects**. The spatial/temporal concentrations of the fisheries are expected to be inconsequential to animals in this category under all of the alternative FMP scenarios, and are therefore rated as insignificant.

- **Persistent Past Effects.** Persistent past effects on spotted seal include foreign, JV, and domestic groundfish fisheries and State-fisheries. For Other Species, no persistent past effects are identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries within the range of spotted seal would be expected to be conducted in the future in a manner similar to the baseline conditions. Future effects of spatial/temporal concentration of fisheries on ice seals and walrus would not be expected.

- **Cumulative Effects.** The spatial/temporal concentration of the groundfish fishery and all other fisheries is considered to have an insignificant cumulative effect on pinniped prey due to limited overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects.** Increased levels of disturbance from the baseline are expected under the FMP 2.1 and are considered conditionally significant adverse.

- **Persistent Past Effects.** Past sources of disturbance of spotted seals have come from the foreign, JV, and the federal domestic groundfish fisheries in the BSAI and state-managed fisheries for salmon. Overlap of fisheries is minimal for most of species. The primary source of external disturbance to the "other pinniped" category would be related to the subsistence harvest.

- **Reasonably Foreseeable Future.** State-managed fisheries could be expected to continue at a level similar to the baseline conditions. Disturbance from subsistence harvest activities in future years would be expected to be similar to the baseline conditions.

- **Cumulative Effects.** Disturbance was determined to be cumulative based on both internal and external effects. This cumulative effect is found to be conditionally significant adverse, especially for walrus, based on repeal of groundfish area closures and greatly increased fishing activity. This rating is conditional on the location and timing of the expanded fisheries actually causing population-level effects on the different species.

Direct/Indirect Effects FMP 2.2

Incidental Take/Entanglement in Marine Debris

Due to the low level of documented interactions between other pinnipeds and groundfish fisheries, incidental takes and entanglements of other pinnipeds under FMP 2.2 are likely to be similar to the baseline condition and are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Effects do not deviate from those described under 2.1 and are considered insignificant.

Spatial/Temporal Concentration of the Fishery

Effects do not deviate from those described under 2.1 and are considered insignificant.

Disturbance

Disturbance of pinnipeds under FMP 2.2 is not expected to increase relative to the baseline and is therefore considered to be insignificant.

Cumulative Effects

The past/present effects on the other pinnipeds are described in Section 3.8.3 and Sections 3.8.5 through 3.8.9 (Tables 3.8-3 and 3.8-5 through 3.8-9). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Effects of incidental take and entanglement under FMP 2.2 are considered insignificant.

- **Persistent Past Effects.** Persistent past effects on other pinnipeds are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on other pinnipeds are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of mortality on other pinnipeds is the same as described under FMP 2.1 and is considered insignificant.

Prey Availability

- **Direct/Indirect Effects.** Effects on prey availability under FMP 2.2 are considered insignificant.

- **Persistent Past Effects.** Persistent past effects on other pinnipeds are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on other pinnipeds are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of prey availability on other pinnipeds is the same as described under FMP 2.1 and is considered insignificant.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on other pinnipeds are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on other pinnipeds are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of spatial/temporal concentration of harvest is the same as described under FMP 2.1 and is considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on other pinnipeds are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on other pinnipeds are the same as described under FMP 2.1

- **Cumulative Effects.** Cumulative effects of disturbance on other pinnipeds are likely to be similar to the baseline condition and are therefore considered insignificant and unlikely to have population effects on any species considered.

4.6.8.6 Transient Killer Whales

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

Increased harvest rates under this management alternative may result in the increased take of fewer than one killer whale relative to the baseline (see section 4.5.8.6), for a total estimated average of fewer than 3 animals per year. Most incidental takes in the fisheries are probably resident killer whales since they feed on fish and would be more likely to be drawn to fishing vessels. This level of incidental take would not result in changes to the population trajectory of transient killer whales. Therefore, takes and entanglements of transient killer whales incidental to groundfish fisheries under FMP 2.1 are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The diet of transient killer whales consists of marine mammals. Since the groundfish fisheries are expected to kill very few marine mammals through incidental take under FMP 2.1, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant under FMP 2.1.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant under FMP 2.1.

Disturbance

FMP 2.1 would result in the repeal of area closures established for the protection of environmental components other than Steller sea lions, such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of marine mammals under FMP 2.1 may increase to the level that population level effects could occur and is, therefore, determined to be conditionally significant adverse to transient killer whales.

Cumulative Effects

The past/present effects on the transient killer whales are described in Section 3.8.22 (Table 3.8-22) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effect.** With regard to incidental take, FMP 2.1 is likely to have insignificant effects on the population trajectory of transient killer whales.

- **Persistent Past Effects.** Mortality has been documented in the JV fisheries, domestic groundfish fisheries, state-managed fisheries, and intentional shootings. Past incidental take in the groundfish fisheries is fewer than two animals per year but it is not known if these animals were transients or residents. In addition to mortalities caused by entanglement, killer whales are also susceptible to injury or mortality through vessel strikes. One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002). The EVOS resulted in the loss of half of the individual killer whales from the AT1 pod in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and for protection as a depleted stock under the MMPA. Contaminant levels in whales in this group were found to be many times higher than in other killer whales (Makin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Mortality from external factors is identified for other state-managed fisheries, intentional shooting, and marine pollution, particularly bio-accumulating pollutants such as DDT and PCBs (Matkin *et al.* 1999).

- **Cumulative Effects.** Mortality is considered cumulative based on the internal effects of the groundfish fisheries and external effects of other fisheries. The cumulative effects are determined to be insignificant and are unlikely to have population level effects. The exception to this finding is the AT1 transient group in PWS. The cumulative effect of mortality on this group was determined to be significantly adverse due to the past external effects of the EVOS and subsequent population decline.

Prey Availability

- **Direct/Indirect Effects.** Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant.

- **Persistent Past Effects.** Since marine mammals are the primary prey of transient killer whales, all of the factors that have been identified as affecting the abundance or distribution of cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include commercial and subsistence harvest, intentional shootings, incidental take in all fisheries, marine pollution, climate change, and regime shifts. In addition, there is the potential for past indirect effects of fisheries on the abundance of Steller sea lions, fur seals, and harbor seals, all of which are important prey species for transient killer whales. Declines in harbor seals in PWS after the EVOS could have affected the AT1 group of transient killer whales through their food supply (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey species important to transient killer whales, primarily marine mammals, would include state-managed fisheries to a smaller extent and subsistence harvest of the various marine mammals.

- **Cumulative Effects.** The cumulative effects on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may specialize on particular prey species, the ability of these top predators to switch prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey. The overall availability of prey does not appear to be having population level effects on transient killer whales and therefore the cumulative effect is considered insignificant.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant.

- **Persistent Past Effects.** All persistent past effects that have been identified for cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include the potential contribution of the spatial/temporal concentration of past fisheries to have caused localized depletion of prey for Steller sea lions, harbor seals, and northern fur seals with consequent population-level effects on those species.

- **Reasonably Foreseeable Future External Effects.** The future spatial/temporal concentration of external fisheries could have indirect effects on the abundance and distribution of marine mammals that are important prey for transient killer whales.

- **Cumulative Effects.** The cumulative effects of the spatial/temporal concentration of fisheries on different marine mammal species result in changes to the abundance and distribution of prey to transient killer whales. Since transient killer whales. are able to switch prey and forage over vast areas, the potential localized depletion of any one species or stock of marine mammal prey is unlikely to have population level effects on the killer whales. The cumulative effect of the spatial and temporal harvest of fish from all fisheries does not appear to be having population level effects on transient killer whales and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance to killer whales are expected to increase substantially from the baseline and are rated conditionally significant adverse.

- **Persistent Past Effects.** Some levels of disturbance have likely come from foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Vessel traffic external to the fisheries has also contributed to overall disturbance of these animals. Effects of the level of disturbance on transient killer whales are largely unknown.

- **Reasonably Foreseeable Future External Effects.** External effects of State-managed fisheries and other vessel traffic on disturbance will likely occur in future years at a level similar to the baseline.

- **Cumulative Effects.** Disturbance of transient killer whales was determined to be cumulative based on the presence of both internal and external factors. This cumulative effect is considered conditionally significant adverse and likely to have population level effects. This is conditional on the actual location and timing of the disturbance and whether transient killer whales are displaced from areas important to the species to the extent that population level effects occur.

Direct/Indirect Effects FMP 2.2

For transient killer whales, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

Disturbance of killer whales under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore rated insignificant.

Cumulative Effects

For transient killer whales, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.
- **Persistent Past Effects.** Persistent past effects on the transient killer whales are the same as described under FMP 2.1.
- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on transient killer whales are the same as described under FMP 2.1.
- **Cumulative Effects.** Disturbance of transient killer whales was determined to be cumulative based on the presence of both internal and external factors. This cumulative effect is expected to be generally similar to the baseline condition, is not likely to have population-level effects, and is therefore considered insignificant.

4.6.8.7 Other Toothed Whales

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 2.1 is not likely to result in significant changes to the population trajectories of toothed whales, including the endangered sperm whale. Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels thought to be insignificant to toothed whale populations (see Section 4.5.8.7).

Fisheries Harvest of Prey Species

The effects of the alternatives on the toothed whales are largely constrained by differences between their prey and the fisheries harvest targets. FMP 2.1 is not expected to increase the level of interactions relative to the baseline and are determined to be insignificant at the population level.

Spatial/Temporal Concentration of the Fishery

Groundfish fisheries have little competitive overlap with toothed whales. Spatial and temporal fishing measures under the baseline conditions do not appear to be causing localized depletion of prey for any species of toothed whale. Changes to the spatial/temporal concentration of the fisheries under FMP 2.1 are expected to result in effects that are insignificant to toothed whales at the population level.

Disturbance

FMP 2.1 repeals area closures established for the protection of environmental components other than Steller sea lions such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to the level that population level effects could occur and is therefore determined to be conditionally significant adverse to endangered sperm whales and other toothed whales.

Cumulative Effects

The past/present effects on the other toothed whale category are described in Section 3.8.19 through 3.8.21 and 3.8.23 through 3.8.25 (Tables 3.8-19 through 3.8-25) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above. The effects considered in this analysis are listed in Table 4.6-5. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels thought to be insignificant at the population level for all species in the toothed whale category and are therefore insignificant.

- **Persistent Past Effects.** Persistent past effects on species within the other toothed whale group include incidental take and entanglement in foreign, JV, federal domestic groundfish fisheries and state-managed fisheries and subsistence hunting on beluga whales. The decline of the Cook Inlet beluga population is thought to have resulted from subsistence harvests, which ranged from 21 to 123 animals per year between 1993 and 1998. Only one beluga was harvested in 2001 by hunters from Native Village of Tyonek and one beluga in 2002 by the Cook Inlet community hunters. Belugas are incidentally taken in the state-managed salmon gillnet fisheries in Bristol Bay and Cook Inlet. However, one beluga was reported to be taken from the eastern Bering Sea stock in 1996 and 7 were reported taken in Bristol Bay in 2000. In the BSAI and GOA groundfish fisheries, no mortality or serious injuries to belugas have been observed. Harbor porpoise have not been taken in the observed groundfish fisheries over a ten-year period between 1990 to 1998 (Angliss and Lodge

2002). Salmon gillnet fisheries in southeast Alaska take approximately 3 individuals per year. Dall porpoise mean annual mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery. The Alaska Peninsula/Aleutian Island salmon drift gillnet fishery has a higher take of Dall's Porpoise with an estimated 28 porpoises in one year (1990). Thousands of Pacific white-sided dolphins were killed annually between 1978 and 1991 in the high seas driftnet fisheries, which no long occur (Angliss *et al.* 2001). During the same time span, one Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery (Angliss *et al.* 2001). State-managed salmon gillnet fisheries take approximately 2 dolphins per year.

Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 with high counts occurring in 1968 when 16,357 sperm whales were harvested, after which the population was severely depleted. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. Sperm whales have been known to prey on sablefish caught on commercial longline gear in the GOA. Only three entanglements have been reported in the GOA longline fishery.

For killer whales, the combined mortality from the observed groundfish fisheries was 1.4 whales per year (Angliss *et al.* 2001). While it is most likely that whales interacting with fisheries are from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks.

For beaked whales (Baird's, Cuvier's, or Stejneger's), no incidental take or entanglement in BSAI and GOA groundfish trawl, longline, and pot fisheries has been documented (Hill and DeMaster 1999).

- **Reasonably Foreseeable Future External Effects.** Future effects on mortality of these species were identified for state-managed fisheries and subsistence for some species such as the beluga whale. Total mortality from these sources is expected to be very minimal.

- **Cumulative Effects.** Cumulative effects of mortality were determined to be insignificant for all non-ESA-listed species based on the internal contribution from the groundfish fisheries and external contribution from other sources. This cumulative effect rating is due to the low level of incidental take in the groundfish fisheries and limited external human-caused mortality.

  For the endangered sperm whale, the cumulative effect of mortality was also considered insignificant due to the very low level of incidental take from the groundfish fisheries and other fisheries and very limited human-caused mortality from external sources.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 2.1 on the toothed whales are largely constrained by differences between their prey and the fisheries harvest targets and are determined to be insignificant at the population level.

- **Persistent Past Effects.** Past effects on the availability of prey for this group are identified for fisheries in general and include the foreign, JV, and federal domestic groundfish fisheries and the state-managed fisheries for salmon and herring. The diversity of diet in this whale group results in limited overlap for most species with the possible exception of sperm whales and resident killer whales.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries were identified as an external factor having a potential effect on prey for these species in the future. Climate and regime shift are also identified but the direction and magnitude of these effects could be either beneficial or adverse.

- **Cumulative Effects.** The ability of these whale species to forage over wide areas and on a variety of prey species moderates any potential impacts from fisheries competition. Cumulative effects on prey availability were identified for this group, including a very limited contribution from the groundfish fishery, but the degree of fishery harvest and bycatch of prey important to these whale species is not expected to have population-level effects on any species, including the endangered sperm whale, and is therefore considered insignificant.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effect.** The groundfish fisheries have little competitive overlap with toothed whales so changes to the spatial/temporal concentration of the fisheries under FMP 2.1 are expected to result in effects that are insignificant to toothed whales at the population level.

- **Persistent Past Effects.** The spatial/temporal concentration of foreign, JV, and domestic groundfish fisheries and the State-managed fisheries are believed to have had minimal effects on the abundance and distribution of toothed whale prey.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue in similar manner as the under the baseline conditions. Effects of future external activities on toothed whale prey are expected to be minimal.

- **Cumulative Effects.** The ability of toothed whales to forage over wide areas and on a variety of prey species moderates any potential impacts from localized depletion of prey from the spatial/temporal concentration of fisheries. Cumulative effects on prey abundance and distribution, including a very limited contribution from the groundfish fishery, are not expected to have population-level effects on any species, including the endangered sperm whale, and are therefore considered insignificant.

Disturbance

- **Direct/Indirect Effect .** Increased levels of disturbance from the baseline are expected under the FMP 2.1 and are considered conditionally significant adverse.

- **Persistent Past Effects.** Past potential disturbance effects on species in this group were identified for foreign, JV, and federal domestic groundfish fisheries; however, there is little indication of an adverse effect of this level of disturbance. General vessel traffic likely also contributes to disturbance to these species.

- **Reasonably Foreseeable Future External Effects.** Increases in the general marine vessel traffic and continued fishing activity in the state-managed fisheries were identified as potential sources of disturbance for these species.

- **Cumulative Effects.** Disturbance was determined to be cumulative based on both internal and external effects. This cumulative effect is considered conditionally significant adverse and likely to have population level effects for endangered sperm whale and other toothed whales. This rating is conditional on the actual location and timing of the disturbance and whether toothed whales are displaced from important foraging areas to the extent that population level effects occur.

Direct/Indirect Effects FMP 2.2

For toothed whales in this group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

Disturbance of toothed whales under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore considered to be insignificant.

Cumulative Effects

For toothed whales in this group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on endangered sperm whales and non ESA-listed toothed whales are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on endangered sperm whales and non ESA-listed toothed whales are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance from both internal and external effect on endangered sperm whales and non ESA-listed toothed whales is likely to be similar to the baseline level and is considered insignificant at the population level for all species.

4.6.8.8 Baleen Whales

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With respect to take and entanglement in marine debris incidental to groundfish fisheries, FMP 2.1 does not conflict with any recovery plan for endangered whales, and is expected to have an insignificant effects on the population trajectories of baleen whales. See the discussion provided for incidental take of other baleen whales in Section 4.5.8.8.

Fisheries Harvest of Prey Species

The effects of FMP 2.1 are determined to be insignificant to baleen whale species in regards to harvest of prey due to the lack of competitive overlap in species targeted by each.

Spatial/Temporal Concentration of the Fishery

Groundfish fisheries have very little competitive overlap with baleen whales for forage species, therefore, changes to the spatial/temporal concentration of the fisheries under FMP 2.1 are expected to result in effects that are insignificant to baleen whales at the population level.

Disturbance

FMP 2.1 repeals area closures established for the protection of environmental components other than Steller sea lions such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to the level that population-level effects could occur and is therefore determined to be conditionally significantly adverse to endangered baleen whale species and other non ESA-listed baleen whales.

Cumulative Effects

The past/present effects on the other baleen whale group are described in Sections 3.8.11 through 3.8.18 (Tables 3.8-11 through 3.8-18) and the predicted direct/indirect effects of the groundfish fishery under the FMP 2.1 bookend are described above (Table 4.6-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.6-1).

Mortality

- **Direct/Indirect Effects.** The low level of take of baleen whales projected to occur under FMP 2.1 is considered insignificant.

- **Persistent Past Effects.** Commercial whaling during the last century has had a lingering effect on almost all of the baleen whales in this group, with the possible exception of the minke whale. These include the endangered blue whales, fin whales, sei whales, humpback whales, northern right whales and the non ESA listed gray whales. A full discussion of the effects of commercial whaling is presented in Section 3.8.9. Subsistence whaling has also affected several of the baleen whales in the past. Gray whales are harvested both in Alaska and in Russia with a 5-year quota of 620 whales. The 1968-1993 average take for Russian and Alaska Natives combined was 159 whales per year. Bowhead whales are harvested under International Whaling Commission which allows up to 67 strikes per year although actual strikes have been fewer than the quota since 1978. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Fin whales were reported in this region year-round, most often in the summer and autumn (POP 1997). Humpback whales are present year-round in Alaska waters but are most frequently reported during the summer and autumn. In 1997, a dead humpback was found entangled in netting and trailing orange buoys near the Bering Strait. It is often difficult to determine if the entanglement occurred with active or derelict gear, or to identify the fishery the derelict gear originated from. Two mortalities (in October 1998 and February 1999) were reported by observers in the BS pollock trawl fishery operating near Unimak Pass. The extent of interactions between bowhead whales and the groundfish fishery are not known. Bowhead whales are present in the Bering Sea during winter and early spring but are usually associated with ice-covered regions. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Of 236 bowhead whales examined from the Alaskan subsistence harvest (from 1976 to 1992), three had visible ship-strike injuries from unknown sources and six had ropes attached or scars from fishing gear (primarily pot gear), one found dead was entangled in ropes similar to those used with fishing gear in the Bering Sea (Philo *et al.* 1992). Since 1992, additional bowhead whales have been observed entangled in pot gear or with scars from ropes. The extent of interactions between gray whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Since 1997, five entanglements (mostly in pot gear) and one ship strike mortality have been reported in Alaska waters. Since 1989, no incidental takes of right whales are known to have occurred in the north Pacific. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. Because the right whale population is believed to be very small, any mortality incidental to commercial fisheries would be considered to be significant. Yet, based on the lack of reported mortalities of right whales, the estimated annual mortality rate incidental to commercial fisheries is zero whales per year from this stock.

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and State-managed fisheries are expected to continue to take small numbers of baleen whales in the coming years. Entanglement in fishing gear will also continue to affect baleen whales throughout their ranges. Subsistence for gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal effects of the fishery and contributions from external factors are considered conditionally significant adverse for fin, humpback, and northern right whales due to past effects on their population, potential for interactions with fisheries, and their endangered status. Right whales are very rare so even one human-caused mortality could be considered significant. Given the overlap of their preferred habitat with the BSAI fisheries, the chances of future adverse interactions with fishing gear are more than negligible. The adverse rating for these three species is conditional on whether future take or entanglement substantially affects their rates of recovery. Cumulative effects are found to be insignificant for the endangered blue, bowhead, and sei whales. These species rarely interact with the fisheries so population-level effects are not anticipated. Mortality is also considered insignificant for non-ESA-listed minke and gray whales. Population-level effects are not expected for either of these species.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 2.1 are determined to have an insignificant effect on both endangered and non ESA-listed baleen whale species due the lack of competitive overlap in species targeted.

- **Persistent Past Effects.** Persistent past effects on availability of prey were not identified due to the lack of competitive overlap in prey species targeted.

- **Reasonably Foreseeable Future External Effects.** Future effects were identified for state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species would not be affected through prey.

- **Cumulative Effects.** The cumulative effects of prey availability are considered insignificant for both endangered and non ESA-listed whale species in this group due to the limited overlap of prey species with the fisheries. Population-level effects are not anticipated.

Temporal and Spatial Concentration of the Fishery

- **Direct/Indirect Effect.** Changes to the spatial/temporal concentration of the fisheries are expected to result in insignificant effects for both endangered and non ESA-listed baleen whales at the population-level.

- **Persistent Past Effects.** Persistent past effects of temporal and spatial concentrations of the fisheries were not identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries would continue to contribute some degree of effect on several species of baleen whales.

- **Cumulative Effects.** Cumulative effects on prey availability are not likely to have population-level effects due to the very low overlap in prey species for this group and are considered insignificant. The contribution of the groundfish fisheries is minimal.

Disturbance

- **Direct/Indirect Effects.** Increased levels of disturbance in comparison to the baseline would likely occur to both endangered and non ESA-listed baleen whales under the FMP 2.1and are considered conditionally significant adverse.

- **Persistent Past Effects.** Some level of disturbance has likely occurred from foreign, JV, and domestic groundfish fishing and state -managed fisheries along with general vessel traffic. For some species such as the gray whale and bowhead whale, subsistence activities have contributed to disturbance of these animals.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and general vessel traffic from recreational boating and whale watching to commercial fishing would be expected to continue in future years and well as subsistence activities.

- **Cumulative Effects.** The cumulative effects of disturbance were determined to likely result in population-level effects for both endangered and non ESA-listed species in this group and, therefore, are considered conditionally significant adverse. This rating is conditional on the actual location and timing of the disturbance and whether baleen whales are displaced from important foraging areas to the extent that population level effects occur.

Direct/Indirect Effects FMP 2.2

For baleen whales, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

<u>Disturbance</u>

Disturbance of both endangered and non ESA-listed baleen whales under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore considered insignificant.

Cumulative Effects

For baleen whales, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

<u>Disturbance</u>

- **Direct/Indirect Effect.** Similar levels of disturbance as those that occurred to both endangered and non ESA-listed baleen whales under baseline conditions are expected under FMP 2.2 and are considered insignificant.

- **Persistent Past Effects.** Persistent past effects of disturbance are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects of disturbance on baleen whales are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external sources is determined to be similar to the baseline condition and not likely to result in a population-level effect for any of the species in this group. Therefore, the cumulative effect is considered to be insignificant.

4.6.8.9 Sea Otters

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Incidental Take/Entanglement in Marine Debris

With respect to take and entanglement in marine debris incidental to groundfish fisheries, FMP 2.1 and FMP 2.2 are not expected to result in significant effects on the population trajectories of sea otters. See the discussion provided for incidental take of sea otters in Section 4.5.8.9.

Fisheries Harvest of Prey Species

Given the minor importance of groundfish in their diet (see Section 4.5.8.9), fisheries removals under FMP 2.1 and FMP 2.2 are not expected to substantially alter sea otter prey abundance relative to the baseline and are considered to have insignificant effects on sea otters.

Spatial/Temporal Concentration of the Fishery

The grounds for suggesting competition for forage between sea otters and commercial fisheries is weak despite the broad geographical distribution of sea otters in the GOA and the Aleutian Islands. Sea otters inhabit waters of the open coast, as well as bays and the inside passages of southeastern Alaska. Since their primary prey items are found on the bottom in the littoral zone, to depths of 50 m, the majority of otters feed within 1 km of the shore (Kenyon 1969). In areas where shallow waters extend far offshore (e.g., Unimak Island), sea otters have been reported as far as 16 km offshore. They are often seen resting and diving for food in and near kelp beds (Kenyon 1969). Because of this habitat preference for shallow areas, they do not overlap spatially with groundfish fisheries. Therefore, the effects of the spatial/temporal concentrations of the fisheries are insignificant for sea otters for both FMP 2.1 and FMP 2.2

Disturbance

FMP 2.1 repeals area closures established for the protection of environmental components other than Steller sea lions, such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. The level of disturbance on sea otters is not expected to increase under FMP 2.1 due to the spatial partitioning of sea otters, which occur in shallow, nearshore areas, and groundfish fisheries. The disturbance levels predicted under FMP 2.2 are not expected to deviate from baseline conditions. Therefore, the effects of disturbance from groundfish fisheries on sea otters are rated insignificant according to the criteria in Table 4.1-6.

Cumulative Effects

The past/present effects on the sea otter are described in Section 3.8.10 (Table 3.8-10) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described above. The effects considered in this analysis are listed in Table 4.5-70. Representative direct effects used in this analysis include mortality and disturbance with major indirect effects being availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The effects on sea otters under FMP 2.1 and FMP 2.2 are considered insignificant, with respect to incidental catch and entanglement.

- **Persistent Past Effects.** Commercial exploitation for pelts had a huge impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Protective measures instituted in 1911 have allowed remnant groups to increase and reoccupy much of the historic sea otter range in Alaska (Kenyon 1969, Estes 1980). Residual effects from this early harvest likely persist in several areas. Alaska Natives have hunted sea otters for pelts and meat throughout history. Current harvest levels represent 9 percent of PBR for the southwestern stock, 15 percent of PBR for the southcentral stock, and 35 percent of PBR for southeast stock. (USFWS 2002a, 2002b, and 2002c). In 1992, fisheries observers reported 8 sea otters taken incidentally by the Aleutian Island Black Cod Pot Fishery. During that year, only a third of the fisheries were observed, yielding an estimate of 24 otters killed in cod pot gear. No other sea otter takes were reported from observed fisheries in the range of the southwest stock from 1993 through 2000. In 1997, one sea otter was reported to have been taken by the BSAI groundfish trawl fishery (USFWS 2002a, 2002b, and 2002c). Oils spills, such as the EVOS, can result in substantial mortality of sea otters. Sea otter numbers have declined dramatically from the Alaska Peninsula to the Bering Sea, and this stock is being considered for listing under the ESA.

- **Reasonably Foreseeable Future External Effects.** Low levels of incidental take in commercial and subsistence fisheries, subsistence hunting, and periodic mortalities from oil spills are likely to continue in the future. Population-level effects from transient killer whale predation may continue in the southwest Alaska stock, depending on the recovery of alternate prey and behavior of transient killer whales.

- **Cumulative Effects.** The cumulative effects of mortality from all sources are different for different stocks of sea otters. The populations of the southeast and southcentral stocks of sea otters appear to be stable or increasing and are not expected to have additional mortality pressures in the future. These stocks are therefore considered to experience insignificant effects from mortality. The rapid decline of the southwest Alaska stock does not appear to be the result of food shortages, disease, or toxic contamination and is likely the result of increased predation by transient killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al.* 1998). Since the mechanisms of the population decline are still under investigation, the cumulative effects on the southwest stock are considered conditionally significant adverse through mortality and are conditional on whether excessive mortality is a primary cause for the recent decline.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 2.1 and FMP 2.2 on sea otters are limited by differences between their prey and the fisheries harvest targets. Sea otters consume a wide variety of invertebrate prey species and occasionally groundfish (e.g., sablefish, rock greenling, and Atka mackerel). As such, the effects of harvest of key prey species in groundfish fisheries are determined insignificant for sea otters.

- **Persistent Past Effects.** Groundfish fisheries have had little effect on the availability of prey in the past due to the limited overlap in prey species of the sea otter and the fish targeted by the groundfish fisheries. There is some minor overlap in state-managed crab fisheries with sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters were identified as external sources for effects on prey availability. The overlap primarily occurs in inshore areas or offshore areas with relatively shallow water.

- **Cumulative Effects.** Cumulative effects of prey availability were determined to be insignificant due to the very limited overlap between fisheries and sea otter forage species and are not likely to have population-level effects on sea otters.

Spatial/Temporal Concentration of the Fisheries

- **Direct/Indirect Effects.** Despite the broad geographical distribution of sea otters in the GOA and the Aleutian Islands, they do not generally overlap spatially with groundfish fisheries. Therefore, the effects of the spatial/temporal concentrations of the fisheries are insignificant for sea otters.

- **Persistent Past Effects.** The limited overlap of groundfish fisheries and other fisheries in the past has resulted in limited interaction with sea otters. Past effects may come from spatial/temporal concentration and have likely occurred in very specific areas associated with state-managed crab fisheries.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries are likely to continue into the future at a level similar to the baseline conditions.

- **Cumulative Effects.** Cumulative effects of spatial/temporal concentration of the fisheries are insignificant due to the limited overlap with sea otter habitat and are unlikely to result in population-level effects.

Disturbance

- **Direct/Indirect Effects.** The effects of disturbance caused by vessel traffic, fishing operations, and sound production on sea otters in the GOA and BSAI are expected to be insignificant. Levels of disturbance under the FMP 2.1 and FMP 2.2 are expected to be similar to the baseline and are considered insignificant to sea otter populations.

- **Persistent Past Effects.** Past effects of disturbance are primarily related to minor disturbance by vessel traffic from fisheries and other vessels associated with subsistence harvest of sea otters.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue at a level similar to the baseline. Vessel traffic within sea otter habitat in future years would also be expected to be similar to the baseline.

- **Cumulative Effects.** Cumulative effects of disturbance on sea otters are considered insignificant and unlikely to result in any population-level effects. Contribution of the groundfish fishery to the overall cumulative effect is minimal.

4.6.9 Socioeconomic Alternative 2 Analysis

This policy alternative would maximize biological and economic yield from the resource while still preventing overfishing of the groundfish stocks. This section contains both quantitative and qualitative assessments of select economic and social effects of FMP 2.1 and FMP 2.2.

4.6.9.1 Harvesting and Processing Sector Profiles

The model and analytical framework used in the analysis of the effects of FMP 2.1 on the harvesting and processing sectors are described in Section 4.1.7.

As in FMP 1, model projections are based on 2001 prices and product mixes. Actual prices may rise or decline with levels of catch, changes in market conditions, or other factors. Since FMP 2.1 results in large increases in the catches of certain species for both catcher vessels and catcher processors, prices may decrease for some species as a result of the increase in supply. The extent to which prices would decrease depends on demand elasticities. Due to the presence of a large number of substitutes for Alaska groundfish products, the demand for these products is believed to be relatively elastic. In other words, prices for groundfish products are unlikely to be substantially influenced by changes in harvests. Also, ex-vessel prices are determined by negotiations between individual processors on one side and either bargaining associations for catcher vessels or individual fishermen on the other side. Ex-vessel prices may not behave as one might expect in a competitive market. Actual prices will ultimately depend on the relative bargaining power of harvesters and processors.

Moreover, the FMP 2.1 model projections of groundfish retained harvests may be overestimated. The elimination of the observer program in all fisheries except the BSAI pollock fishery will increase the reliance of fishery managers on the data collected through current industry recordkeeping and reporting requirements. A reliance on logbook data will significantly decrease the precision of total catch data available for fishery managers. With less precise data, fishery managers are likely to adopt a conservative approach and close fisheries before actual catches reach the TAC.

Table 4.6-6 summarizes projected impacts of FMP 2.1 on the harvesting and processing sectors. The numbers in the table reflect the 5-year average of outcomes projected for 2003 to 2007. Under FMP 2.1, there would be significant increases in the harvest of groundfish species as a result of a large projected increase in the TAC and the removal of PSC limits. The 5-year mean estimate of groundfish wholesale product value is about $2.2 billion, a 52 percent increase when compared to the baseline.

Under FMP 2.1, groundfish wholesale product value is projected to be at a peak of $2.8 billion in 2003. However, the harvest of pollock in the BSAI in that year is predicted to be unsustainable. Consequently, product value is expected to decline rapidly such that product value in 2006 is approximately 68 percent of the 2003 estimated value and 86 percent of the 5-year mean. An upward trend is expected after 2006, and by 2007, the product value is anticipated to be about $1.9 billion.

The 5-year mean estimate of the pollock harvest is 680 thousand mt (47 percent) higher than the comparative baseline. Pacific cod harvest are expected to increase by 165 thousand mt (75 percent), and harvest of flatfish are predicted to increase by 103 thousand mt (60 percent). Species in the A-R-S-O aggregation as a whole are predicted to increase by 40 thousand mt (27 percent). Total groundfish payments to labor are expected to increase by 54 percent, and groundfish employment will increase by about 6,900 FTE positions.

4.6.9.1.1 Catcher Vessels

Direct/Indirect Effects of FMP 2.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period in Table 4.6-6 to 2001 catcher vessel conditions reveals that under FMP 2.1 there would be a significant increase in retained harvests of pollock and Pacific cod relative to the comparative baseline. The large projected increase in the TAC for these species and the removal of PSC limits are expected to increase catches of pollock and Pacific cod by about 48 percent and 188 percent, respectively. Retained harvests of A-R-S-O species are also expected to increase significantly.

Ex-Vessel Value

As a result of the predicted increases in harvest tonnage of groundfish species, the ex-vessel value of groundfish landed by catcher vessels is expected to increase significantly relative to the comparative baseline. Increased pollock harvests by the three classes of AFA-eligible trawl catcher vessels account for much of the increase in groundfish ex-vessel value. In addition, a significant increase in ex-vessel value is expected for small trawl catcher vessels and fixed-gear vessels, largely through an increase in the harvest of Pacific cod and species in the A-R-S-O complex.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase significantly under FMP 2.1.

Impacts on Excess Capacity

FMP 2.1 is expected to substantially increase the quantity of catch and products from the groundfish fisheries. Therefore, a decrease in the level of excess capacity in the harvesting sector is predicted in the short-term. However, because FMP 2.1 repeals all effort limitation programs other than those that are statutorily-mandated, excess capacity in the harvesting sector is expected to significantly increase over the long-term as new vessels and processing facilities enter the groundfish fisheries with a significantly adverse effect in comparison to the baseline condition.

Average Costs

It is difficult to determine the net effect of various influences on average costs, and it will likely vary by fishery and species. Overall, however, a significant increase in average costs is expected under FMP 2.1 relative to the comparative baseline. In the short-term, average costs per unit of catch for some catcher vessels can be expected to decrease somewhat under FMP 2.1 due to the increase in the overall level of production resulting from the increased TAC and elimination of PSC limits. Many costs are fixed (e.g., loan repayments, general office and accounting expenses and insurance costs); they do not change with the level of production. These costs would be allocated to a larger amount of product, thereby lowering the average cost per unit of catch. However, over the long-term it is expected that catch per unit of effort will decrease as harvest levels increase and capital expenditures will increase with the entry of new vessels and intensification of the race for fish. As a result, any cost savings under this FMP would likely be negated.

Variable costs will increase with the increase in catch, and the increase in the supply of fish is likely to put downward pressure on ex-vessel prices. The extent to which processors versus catcher vessels would share changes in harvesting costs and the extent to which catcher vessels are willing to accept lower prices as total supply increases will depend on their relative bargaining power as well as price elasticities of the products made from the fish. However, large decreases in ex-vessel prices and the associated variable costs of production for processors are not expected under FMP 2.1.

Elimination of the current VMS requirement may have a adverse impact on the fishing industry, as it could lead to the closure of all Steller sea lion critical habitat to fishing. By allowing NOAA Fisheries to effectively monitor compliance with a large number of complex area-based fishing restrictions, VMS affords vessels an opportunity for continued access to some historic fishing grounds within critical habitat. In the absence of VMS, it is possible that all critical habitat would have to be closed to fishing should it be determined by NOAA Fisheries that effective monitoring of the remaining Steller sea lion protection measures is no longer possible. The results of such a closure would be an increase in vessel travel time and higher operating costs.

The economic advantage conferred on some sectors of the groundfish fisheries by the elimination of PSC limits would come at the expense of other domestic fisheries in the region. Specifically, the increase in prohibited species bycatch would impose economic costs on harvesters and processors of crab, halibut, herring, and salmon in the form of foregone catches and product. No estimates of these losses under FMP 2.1 are available. However, it is estimated that increased gross revenue in groundfish fisheries would exceed the value of losses incurred in directed fisheries for halibut, salmon, and crab.

<u>Fishing Vessel Safety</u>

It is expected that FMP 2.1 will have both significantly beneficial and adverse effects on fishing vessel safety. However, it is uncertain whether the beneficial effects would outweigh the adverse effects. On the one hand, the increased competition among fishermen is expected to increase the risks fishermen will take to harvest fish. The adverse effects would be particularly severe in the sablefish longline fishery because FMP 2.1 would eliminate the vessel safety benefits of the IFQ program. These benefits result from the elimination of the race for fish and the associated freedom to decide when to fish and at what rate to fish. On the other hand, because FMP 2.1 would remove some fishing restrictions in nearshore areas, it would allow vessels to spend more time fishing nearer to shore and would reduce the potential for the risk of accidents and injury due to hazardous weather and other conditions. This could be particularly true in southeast Alaska where repeal of the LLP would open all of the area east of 144°W longitude to trawling. Other beneficial safety effects are expected to be realized in the Bristol bay area with the opening of the Nearshore Bristol bay closures in areas 506 and 512; along the Aleutian Islands where the Chinook Savings Area, Herring Savings Area, and Red King Crab Closure area would be open; and around Kodiak with the opening of the Kodiak Type 1 and Type 2 Areas.

Cumulative Effects of FMP 2.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety. For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** There would be a significant increase in retained harvest of pollock and Pacific cod relative to the comparative baseline. Increased TAC and the removal of PSC limits are expected to increase catches of pollock and Pacific cod by about 48 percent and 188 percent respectively. Retained harvests of other groundfish species will also increase significantly.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990's, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under "Groundfish Landings By Species Group" at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects.** Although there are currently downward trends in the commercial salmon and crab fisheries, the predicted increases in retained harvests under FMP 2.1 are high enough for many species (187 percent for Pacific cod and 48 percent for pollock) that they are expected to mitigate the reductions in other fisheries. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these effects are not expected to result in significant effects under FMP 2.1. Overall, significantly beneficial cumulative effects are expected under FMP 2.1.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is expected to increase significantly under FMP 2.1, much of which is accounted for by increases in pollock harvests.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990's, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under "Groundfish Landings By Species Group" at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Significantly beneficial cumulative effects are expected for ex-vessel value under FMP 2.1. The significant increases in harvests of Pacific cod, pollock and the A-R-S-O complex (187.6 percent, 48.3 percent, and 17.9 percent, respectively) account for the significant increases in ex-vessel value. Other fisheries reductions are likely to be mitigated by these increases for vessels that participate in multiple fisheries.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Under FMP 2.1 employment and payments to labor are expected to be significantly beneficial (increases of 110 percent and 64 percent respectively) primarily due to the increases in harvest.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The increases in employment and payments to labor (64 percent for both) predicted under FMP 2.1 as a result of increases in TAC and removal of PSC limits are likely to result in significantly beneficial cumulative effects on employment and payments to labor. Potential increases in municipal or landings taxes in rural Alaska communities due to reductions in subsidies and power cost equalization programs could indirectly reduce payments to labor. Although reductions in the salmon and crab fisheries are adversely affecting employment and payments to labor in other fisheries, the increases predicted under FMP 2.1 are expected to mitigate these effects.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** A substantial increase in excess capacity is likely to result due to the repeals of all effort license limitation programs other than those statutorily mandated, with a significantly adverse effect in comparison to the baseline condition. For further details (see the Direct/Indirect section at the beginning of Section 4.6.9.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of 4.5.9.1.

- **Cumulative Effects.** Programs implemented to reduce excess capacity in the groundfish fishery such as the LLP, are eliminated under FMP 2.1 This could result in additional vessels entering the fishery thereby exacerbating existing overcapacity. This, in conjunction with the remaining excess capacity in other fisheries, results in significantly adverse cumulative effects under FMP 2.1 (see Appendix F-8 – Overcapacity Paper).

Average Costs

- **Direct/Indirect Effects.** A significant increase in average costs are expected though they will likely vary by fishery and by species, with a significantly adverse effect in comparison to the baseline condition. These variations are described in further detail in Section 4.6.9.1 under Direct /Indirect Effects on Average Costs above.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** As described in detail under the direct/indirect discussion of average costs at the beginning of Section 4.6.9.1, multiple variables influence changes in average costs such as area closures, transit time, harvest levels, and the race for fish. Recent reductions in government subsidies and power cost sharing programs have caused communities to rely even more on fishing revenues. Thus, there is potential for fish taxes to be raised in upcoming years. This could result in higher average costs. Area closures for the salmon and crab fisheries have the same affects as do groundfish closures, often increasing transit time and operating costs. However, long-term projections suggest that catches per unit of effort will decrease as TACs and capital expenditures increase with the entry of new vessels and intensification of the race for fish. These new entries and the amplification of the race for fish, combined with the effects of other closures in directed fisheries for halibut, salmon, and crab will likely result in significantly adverse cumulative effects under FMP 2.1.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Significantly beneficial and significantly adverse effects are anticipated due to the uncertainty of whether increased competition among fishermen is expected to increase their risks to harvest fish or whether benefits of reduced closures in nearshore areas would reduce safety risks. Details on these variables can be found under the direct/indirect effects discussion at the beginning of Section 4.6.9.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. While additional closures that may result from management measures in other fisheries may increase the risk to fishermen, the reduction of nearshore closures under FMP 2.1 may reduce risks. However, the safety risks are particularly severe under the sablefish longline fishery as a result of the elimination of vessel safety benefits under the IFQ program under this FMP. Significantly beneficial or adverse cumulative effects could result under FMP 2.1.

Direct/Indirect Effects of FMP 2.2

The model and analytical framework used in the analysis of the effects of FMP 2.2 on the harvesting and processing sectors are described in Section 4.1.7.

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 catcher vessel conditions reveals that under FMP 2.2 there would be a significant increase in retained harvests of pollock and Pacific cod relative to the comparative baseline. The projected increase in the TAC for these species is expected to increase catches of pollock and Pacific cod by about 20 percent and 54 percent, respectively. Flatfish harvests are rated as insignificant under FMP 2.2.

Ex-Vessel Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall ex-vessel value of groundfish landed by catcher vessels is expected to increase significantly relative to the comparative baseline. Increased pollock harvests by the three classes of AFA-eligible trawl catcher vessels account for much of the increase in groundfish ex-vessel value. In addition, a significant increase in ex-vessel value is expected for smaller trawl catcher vessels and pot catcher vessels, largely through an increase in the harvest of Pacific cod.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase under FMP 2.2, but the increase is of marginal significance.

Impacts on Excess Capacity

No significant change in excess harvesting capacity is expected to occur under FMP 2.2 relative to the comparative baseline. This FMP would maintain current measures to reduce excess capacity and the race for fish in the Alaska groundfish fisheries. Current measures that address overcapacity include the LLP; the sablefish longline fishery IFQ program, which includes provisions for community purchase of quota shares; the cooperatives established in the BSAI pollock fishery under the AFA, and the western Alaska CDQ program. These measures have been successful in limiting harvesting and processing capacity in Alaska groundfish fisheries, and further decreases in capacity in the BSAI pollock fishery and sablefish longline fishery are expected. However, no additional overcapacity measures would be implemented under this FMP. A recent report by Felthoven *et al.* (2002) indicates that significant excess capacity remains in several groundfish fisheries.

Average Costs

No significant change in average costs is expected to occur under FMP 2.2 relative to the comparative baseline. Average costs per unit of catch for catcher vessels can be expected to decrease somewhat under this FMP due to the increase in the overall level of production resulting from the increased TAC. Many costs are fixed (e.g., loan repayments, general office and accounting expenses and insurance costs); they are not reduced with the level of production. These costs would be allocated to a larger amount of product, thereby lowering the average cost per unit of catch. However, it is possible that catch per unit of effort will decrease as harvest levels increase. This would mitigate the cost savings discussed above. It is difficult to determine the net effect of these influences, and it will likely vary by fishery and species. Nevertheless, over the long-term average costs are not expected to change significantly.

Fishing Vessel Safety

No significant change in fishing vessel safety is expected to occur under FMP 2.2 relative to the comparative baseline. The risk to fishermen is expected to remain high under this FMP. This is in part due to regulations that require fishermen to operate farther from shore or in areas and seasons with more hazardous weather conditions. In particular, the existing area closures will continue to require smaller catcher vessels based out of the Alaska Peninsula, Aleutian Islands, and Kodiak communities to travel far to fish, exposing the vessels to additional safety risks. The continued use of the race for fish to allocate TAC and PSC limits among competing fishermen in some fisheries is also expected to have a adverse effect on fishing vessel safety.

Cumulative Effects of FMP 2.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety. For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** A significant increase in retained harvest of pollock and Pacific cod relative to the comparative baseline is projected under FMP 2.2. Retained harvests of other groundfish species will also increase significantly.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects.** Similar to FMP 1, the predicted increases in retained harvests under FMP 2.2 are marginal for most species, except Pacific cod. The reductions in other fisheries could adversely affect harvest levels in the groundfish fisheries. Overall, significantly beneficial cumulative effects are expected under FMP 2.2.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is expected to increase significantly under FMP 2.2.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Significantly beneficial cumulative effects are expected for ex-vessel value under FMP 2.2. The significant increases in Pacific cod and pollock harvests (51 percent and 20 percent respectively) account for the significant increases in ex-vessel value. Given the decreases in state subsidies for power generation, education and municipal revenue sharing, the importance of fishing, especially in rural Alaska, is increasing. The decreases in state subsidies may however, result in increases in fish landing taxes which could reduce ex-vessel value. The 20 percent increase predicted for overall groundfish ex-vessel value under FMP 2.2, could mitigate these potential effects but that is not likely. Therefore, significantly beneficial cumulative effects are anticipated for ex-vessel value under FMP 2.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Under FMP 2.2, employment and payments to labor are expected to be significantly beneficial (increases of 19 percent and 22 percent respectively) primarily due to the increases in harvest.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The marginal increases predicted for employment and payments to labor under FMP 2.2 associated with increases in retained harvest, especially for Pacific cod. Potential increases in municipal or landings taxes in rural Alaska communities due to reductions in subsidies and power cost equalization programs could indirectly reduce payments to labor. Cumulative effects are likely to be significantly beneficial even though there are current reductions in other fisheries such as salmon and crab and potential increases in fish landing taxes resulting from decreased state and municipal subsidies.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Changes in excess capacity are likely to be insignificant under FMP 2.2.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Excess capacity is not expected to change significantly under FMP 2.2. Although the license limitation efforts help to reduce capacity, it is still predicted to remain high in the groundfish fisheries. Excess capacity is likely to also remain in other fisheries unless management addresses this issue. Therefore, cumulative effects are likely to be insignificant and excess capacity will continue. For details see the Overcapacity Paper in Appendix F-8.

Average Costs

- **Direct/Indirect Effects.** Insignificant effects are expected to occur for average costs under FMP 2.2.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Average costs are not expected to change significantly from the baseline condition under FMP 2.2. Associated or shared costs with other fisheries will continue to have an affect on costs in the groundfish fishery. Recent reductions in government subsidies and power cost sharing programs have caused communities to rely even more on fishing revenues. Thus, there is potential for fish taxes to be raised in upcoming years. This could result in higher average costs. Similar to FMP 1, insignificant cumulative effects are likely under FMP 2.2.

Fishing Vessel Safety

- **Direct/Indirect Effects.** No significant effects on fishing vessel safety are expected to result from FMP 2.2.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Under FMP 2.2, no additional closures are to be implemented other than those that are in place under the baseline condition. Closures implemented through other fisheries may affect vessel safety in the groundfish fisheries, although these closures are not expected to result in a significant cumulative effect on vessel safety.

4.6.9.1.2 Catcher Processors

Direct/Indirect Effects of FMP 2.1

<u>Groundfish Landings By Species Group</u>

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 catcher processor conditions reveals that under FMP 2.1 there would be a significant increase in catches of all groundfish species or species groups relative to the comparative baseline. The large projected increase in the TAC for these species and the removal of PSC limits are expected to increase catches of flatfish, pollock, and Pacific cod by about 71 percent, 45 percent, and 30 percent, respectively. Harvests of A-R-S-O species are expected to increase around 23 percent.

<u>Groundfish Gross Product Value</u>

As a result of the predicted increases in harvest tonnage of groundfish species, the overall wholesale product value of groundfish processed by catcher processors is expected to increase significantly relative to the comparative baseline. This increase is the result of significant increases in the value of pollock products produced by surimi trawl catcher processors and fillet trawl catcher processors; flatfish products produced by head-and-gut trawl catcher processors; Pacific cod products produced by pot catcher processors, longline catcher processor and head-and-gut trawl catcher processors; and products from A-R-S-O species produced by head-and-gut trawl catcher processors and longline catcher processors.

<u>Employment and Payments to Labor</u>

Total groundfish employment and payments to labor by catcher processors are expected to increase significantly under FMP 2.1. Head-and-gut trawl catcher processors, surimi trawl catcher processors and fillet trawl catcher processors account for most of this increase.

<u>Product Quality and Product Utilization Rate</u>

No significant change in overall product quality or product utilization rate is expected to occur under FMP 2.1 relative to the comparative baseline. The product value for the BSAI pollock fishery is expected to remain high as a result of the establishment of the AFA cooperatives and end of the race for fish. These measures will also mitigate the effects of the elimination of IR/IU regulations. However, the resumption of the race for fish in the sablefish longline fishery could result in a decrease in the quality of sablefish product. Because both the intensity of this adverse effect and the probability of its occurrence are uncertain, it is considered conditionally significant adverse.

Excess Capacity

As with catcher vessels, the repeal of all effort limitation programs other than those that are statutorily-mandated is expected to result in a significant increase in excess capacity in the harvesting sector in the long-run with a significantly adverse effect in comparison to the baseline condition.

Average Costs

As with catcher vessels, a significant increase in average costs is predicted under FMP 2.1 relative to the comparative baseline as a result of lower catches per unit of effort associated with higher TACs and because of the increase in capital expenditures with the entry of new vessels and intensification of the race for fish. Thus, there would be a significantly adverse effect under FMP 2.1.

Fishing Vessel Safety

As with catcher vessels, either a significant improvement or reduction in fishing vessel safety could occur under FMP 2.1 relative to the comparative baseline. On the one hand, the increased competition among fishermen is expected to increase the risks fishermen will take to harvest fish. On the other hand, because FMP 2.1 would remove some fishing restrictions in nearshore areas, it would allow vessels to spend more time fishing nearer to shore and would reduce the potential for the risk of accidents and injury due to hazardous weather and other conditions. Thus a significantly adverse or beneficial effect on fishing vessel safety would be expected under FMP 2.1.

Cumulative Effects of FMP 2.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, significantly beneficial effects are expected for retained harvests of groundfish species.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Although there are currently downward trends in the commercial salmon and crab fisheries, the predicted increases in retained harvests under FMP 2.1 are high enough for many species (23 to 71 percent) that they are expected to mitigate the reductions in other fisheries. Overall, significantly beneficial cumulative effects are expected under FMP 2.1. Other economic development activities and other sources of municipal and state revenue are not expected to offset the large increases in TAC in the groundfish fishery. While climate change may result in potential increases or decreases in fish populations as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase significantly from the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Significantly beneficial cumulative effects are expected for gross product value under FMP 2.1. The significant increases in harvests of pollock, flatfish and Pacific cod, in particular, account for the significant increases in value. Other fisheries reductions are likely to be mitigated by these increases for vessels that participate in multiple fisheries.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Significant increases in employment and payments to labor are predicted for catcher processors under FMP 2.1.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase in groundfish employment (44 percent) under FMP 2.1, is so significant that it is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase (39 percent) under FMP 2.1 thereby mitigating some of the reductions in other fisheries. Potential increases in municipal or landings taxes in rural Alaska communities due to reductions in subsidies and power cost equalization programs could indirectly reduce payments to labor, though this is not likely to have a strong effect under FMP 2.1. Therefore, significantly beneficial cumulative effects on employment and payments to labor are anticipated under FMP 2.1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** Overall, insignificant effects in product quality and product utilization rates are expected under FMP 2.1 relative to the baseline. However, the resumption of the race for fish in the sablefish longline fishery could result in a decrease in the quality of sablefish product. Because both the intensity of this adverse effect and the probability of its occurrence are uncertain, it is considered conditionally significant adverse.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed under the Section 4.5.9.1.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. However, the resumption of the sablefish longline fishery could result in decreased product quality. Overall, increases in product quality and utilization are likely in the long-term, though these improvements are not likely to result in significant cumulative effects under FMP 2.1. Due to the uncertainty of the intensity this effect may have on the groundfish fisheries, conditionally significant adverse cumulative effects may occur under FMP 2.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly adverse effects in excess capacity are expected under FMP 2.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of 4.5.9.1.

- **Cumulative Effects.** Excess capacity still remains in other fisheries as well as the groundfish fishery. Measures such as LLP are repealed under FMP 2.1, which is likely to exacerbate the race for fish (Overcapacity Paper Appendix F-8). Given that effort limitation programs are discontinued under this FMP and excess capacity in other fisheries remains, significantly adverse cumulative effects are expected for excess capacity as it is expected to worsen from the baseline level.

Average Costs

- **Direct/Indirect Effects.** Significantly adverse effects in average costs are expected under FMP 2.1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As stated above in Section 4.6.9.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Increases in closure areas increase costs, whereas decreases in closures usually decrease costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with average costs in the groundfish fishery, cumulative effects may result. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. As FMP 2.1 results in a reduction in closures, except for Steller sea lion related measures, cumulative effects on average costs in the groundfish fisheries could be reduced. However, the resumption of the race for fish is likely to increase costs. The expansion of the race for fish, in conjunction with potential increases in closed areas in other fisheries, result in significantly adverse cumulative effects for average costs.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Significantly beneficial and significantly adverse effects are anticipated due to the uncertainty of whether increased competition among fishermen is expected to increase their risks to harvest fish or whether benefits of reduced closures in nearshore areas would reduce safety risks.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As vessel safety is primarily a function of the race for fish, distance to fishing areas and sea conditions relative to vessel size, the reduction in closures under FMP 2.1 are expected to improve vessel safety. However, the race for fish under FMP 2.1 could result in increased risks to vessels. Significantly adverse or beneficial cumulative effects could result under FMP 2.1.

Direct/Indirect Effects of FMP 2.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 catcher processor conditions reveals that under FMP 2.2 there would be a significant overall increase in catches of groundfish species. As a result of a projected increase in the TAC, catches of flatfish and pollock are expected to increase by about 44 percent and 19 percent, respectively. Harvests of Pacific cod are expected to increase around 39 percent.

Groundfish Gross Product Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall wholesale product value of groundfish processed by catcher processors is expected to increase significantly relative to the comparative baseline. This increase is the result of significant increases in the value of pollock products produced by surimi trawl catcher processors and fillet trawl catcher processors; flatfish products produced by head-and-gut trawl catcher processors; and Pacific cod products produced by pot catcher processors, longline catcher processor and head-and-gut trawl catcher processors.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under FMP 2.2, but the increase is of marginal significance. Head-and-gut trawl catcher processors, surimi trawl catcher processors and fillet trawl catcher processors account for most of this increase.

Product Quality and Product Utilization Rate

No significant change in overall product quality or product utilization rate is expected to occur under FMP 2.2 relative to the comparative baseline.

Excess Capacity

As with catcher vessels, no significant change in excess harvesting capacity is expected to occur under FMP 2.2 relative to the comparative baseline. This FMP would maintain current measures to limit capacity and reduce the race for fish in the Alaska groundfish fisheries.

Average Costs

As with catcher vessels, no significant change in average costs is expected to occur under FMP 2.2 relative to the comparative baseline. Fixed costs per ton will decline as catches increase; however, variable cost per ton is expected to increase as the average catch per unit of effort declines in response to higher harvest levels.

Fishing Vessel Safety

As with catcher vessels, no significant change in fishing vessel safety is expected to occur under FMP 2.2 relative to the comparative baseline.

Cumulative Effects of FMP 2.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.6-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Significantly beneficial effects are expected for groundfish landings by species group under FMP 2.2.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Although there are currently downward trends in the commercial salmon and crab fisheries, catcher processors that rely on a mix of groundfish, salmon and crab may experience a reduction in harvest levels. However, this reduction may be offset by the predicted increases in TAC for flatfish, pollock and Pacific cod. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. Significantly beneficial cumulative effects are projected for FMP 2.2.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase significantly from the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). Although during recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing, the increases in product value projected under FMP 2.2 are likely to offset these reductions. Significantly beneficial cumulative effects for groundfish gross product value are anticipated under FMP 2.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Significantly beneficial effects are predicted for catcher processors under FMP 2.2.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The increase in groundfish employment (23 percent) under FMP 2.2, is likely to mitigate some of the current reductions in other fisheries such as crab and salmon. Similarly, payments to labor are also projected to increase (23 percent) under FMP 2.2, thereby mitigating some of the reductions in other fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be significantly beneficial under FMP 2.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** No significant changes in product quality or utilization rate are expected under FMP 2.2 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** As stated under FMP 2.1, advances in technology have improved product quality and utilization for various fisheries throughout the world. Overall, increases in product quality and utilization are likely in the long-term though these improvements are not expected to result in significant cumulative effects under FMP 2.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** No significant changes in excess capacity are expected under FMP 2.2 relative to the baseline. Current measures to reduce excess capacity and the race for fish would be maintained.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 2.2, no cumulative effects are expected for excess capacity as conditions are not expected to change significantly from the baseline.

Average Costs

- **Direct/Indirect Effects.** No significant change in average costs are expected under FMP 2.2 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** As stated under FMP 2.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed and variable costs, as well as area closures also have an effect on average costs. In contrast to FMP 2.1, closures do not change significantly from the baseline condition, and although fixed costs per ton decline as catch increases, variable costs per ton will increase. Insignificant cumulative effects on average costs in the groundfish fisheries are likely under FMP 2.2.

Fishing Vessel Safety

- **Direct/Indirect Effects.** No significant change in fishing vessel safety is expected under FMP 2.2.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, distance to fishing areas and sea conditions relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen, however, these effects are not expected to be significant under FMP 2.2. As there are no predicted increases in area closures under FMP 2.2, cumulative effects on vessel safety are insignificant compared to the baseline condition.

4.6.9.1.3 Inshore Processors and Motherships

Direct/Indirect Effects of FMP 2.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 inshore plant and mothership conditions reveals that under FMP 2.1 there would be a significant increase in catches of pollock and Pacific cod relative to the comparative baseline. The large projected increase in the TAC for these species and the removal of PSC limits are expected to increase catches of pollock and Pacific cod by about 48 percent and 179 percent, respectively. Catches of A-R-S-O species are also expected to increase significantly.

Groundfish Gross Product Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall wholesale product value of groundfish processed by inshore plants and motherships is expected to increase significantly relative to the comparative baseline. Increased deliveries of pollock and Pacific cod to Bering Sea pollock shore plants account for much of the increase in product value. However, the product value of all inshore processing plants and motherships is expected to increase significantly as a result of the overall increase in groundfish catch.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore plants and motherships are expected to increase significantly under FMP 2.1. Bering Sea pollock shore plants account for most of the increase in employment and payments to labor.

Product Quality and Product Utilization Rate

As with catcher processors, no significant change in overall product quality or product utilization rate is expected to occur under FMP 2.1 with the exception of sablefish. The resumption of the race for fish in the sablefish longline fishery could result in a decrease in the quality of sablefish product. Because both the intensity of this adverse effect and the probability of its occurrence are uncertain, it is considered conditionally significant adverse.

Excess Capacity

In general, the increase in the TAC under FMP 2.1 will mean a significant reduction in excess processing capacity as throughput increases. In contrast to catcher vessels and catcher processors, the repeal of effort limitation measures is not expected to a substantial and rapid increase in the capacity of inshore processing facilities because those measures were not directed at controlling processing capacity.

Average Costs

In contrast to the harvesting sector, the inshore processing sector is expected to realize a significant decrease in average costs under FMP 2.1 relative to the comparative baseline. Higher catches in the groundfish fisheries and a larger number of fishing vessels will likely eliminate upward pressure on ex-vessel prices, and greater throughput over constant fixed costs will result in significantly lower average costs for processing facilities.

Cumulative Effects of FMP 2.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are expected to be significantly beneficial with increases in retained groundfish harvests for certain species.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Although there are downward trends in the commercial salmon and crab fisheries, inshore plants and motherships are projected to experience such increases in groundfish harvests that significantly beneficial cumulative effects are anticipated under this FMP. Other economic development activities and other sources of municipal and state revenue can have an effect on the processing plants through landings taxes and other tax mechanisms, however, these are not expected to have significant effects under FMP 2.1.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase significantly from the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). Although during recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing, the dramatic increases in gross product value (62 percent) predicted under FMP 2.1 are likely to result in significantly beneficial cumulative effects.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Significantly beneficial effects are predicted for catcher processors under FMP 2.1.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The increase in groundfish employment (64 percent) under FMP 2.1, is likely to mitigate some of the reductions currently taking place in other fisheries such as salmon and crab. Similarly, payments to labor are also projected to increase (63 percent) under FMP 2.1. Potential increases in municipal or landings taxes in rural Alaska communities due to reductions in subsidies and power cost equalization programs could indirectly reduce payments to labor, though this is not likely to have a strong effect under FMP 2.1. Therefore, significantly beneficial cumulative effects on employment and payments to labor are expected under FMP 2.1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** Insignificant changes in product quality or utilization rate are expected under FMP 2.1 relative to the baseline. However, the resumption of the race for fish in the sablefish longline fishery could result in a decrease in the quality of sablefish product. Because both the intensity of this adverse effect and the probability of its occurrence are uncertain, it is considered conditionally significant adverse.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. However, the resumption of the sablefish longline fishery could result in decreased product quality. Overall, increases in product quality and utilization are likely in the long-term though these improvements are not likely to result in significant cumulative effects under FMP 2.1. Due to the uncertainty of the intensity this effect may have on the groundfish fisheries, conditionally significant adverse cumulative effects may occur under FMP 2.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly beneficial effects in excess capacity are expected under FMP 2.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** The increase in throughput is expected to result in significantly beneficial cumulative effects (Appendix F-8 Overcapacity Paper).

Average Costs

- **Direct/Indirect Effects.** Significantly beneficial effects in average costs are expected under FMP 2.1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As stated in Section 4.6.9.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while product value is variable. In contrast to the harvesting sector, processors that have greater throughput over fixed costs have lower costs as a result. As FMP 2.1 is projected to result in greater throughput for inshore processors and motherships, significantly beneficial cumulative effects are likely. Average costs are expected to be reduced under this FMP.

Direct/Indirect Effects of FMP 2.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 inshore plant and mothership conditions reveals that under FMP 2.2 there would be a significant increase in catches of pollock and Pacific cod relative to the comparative baseline. The projected increase in the TAC for these species is expected to increase catches of pollock and Pacific cod by about 21 percent and 49 percent, respectively.

Groundfish Gross Product Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall wholesale product value of groundfish processed by inshore plants and motherships is expected to increase significantly relative to the comparative baseline. Increased deliveries of pollock and Pacific cod to Bering Sea pollock shore plants account for much of the increase in product value.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore plants and motherships are expected to increase under FMP 2.2, but the increase is of marginal significance.

Product Quality and Product Utilization Rate

No significant change in overall product quality or product utilization rate is expected to occur under FMP 2.2 relative to the comparative baseline.

Excess Capacity

Because processing amounts are expected to increase substantially with the increase in TAC, excess capacity in the inshore processing sector is expected to significantly decrease.

Average Costs

Average costs are expected to decline significantly in the inshore processing sector, as fixed costs are spread over greater throughput amounts. Unlike harvesters, inshore processors are not expected to experience higher variable costs. Rather, economies of scale within this sector are likely to result in lower average variable costs.

Cumulative Effects of FMP 2.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are expected to increase significantly compared to the baseline with increases of 49 percent for Pacific cod and 21 percent for pollock.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** As stated under FMP 2.1, the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon and crab may result in reduction in harvest levels. However, the increases in harvest projected for groundfish species under FMP 2.2 are likely to mitigate some of these reductions and result in significantly beneficial cumulative effects for groundfish landings. Although other economic development activities and other sources of municipal and state revenue can indirectly affect processors due to recent reductions in government subsidies and power cost sharing programs, these effects are not expected to be significant under FMP 2.2.

<u>Groundfish Gross Product Value</u>

- **Direct/Indirect Effects.** The gross product value is expected to increase significantly, especially for Bering Sea pollock shore plants.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut).The recent decline in state municipal revenue sharing, power cost equalization, and contribution to education programs have is not expected to offset the significant increases in gross product value predicted under FMP 2.2 due primarily to the increases in pollock and Pacific cod in the Bering Sea. For these reasons, significantly beneficial cumulative effects on gross product value are expected to result from FMP 2.2.

<u>Employment and Payments to Labor</u>

- **Direct/Indirect Effects.** Significantly beneficial effects are predicted for inshore processors and motherships under FMP 2.2.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Although reductions in the salmon and crab fisheries are currently taking place, the increase in groundfish employment (22 percent) under FMP 2.2 is likely to mitigate some of the reductions in these other fisheries. Similarly, payments to labor are also projected to increase (21 percent) under FMP 2.2 thereby mitigating some of the reductions in other fisheries Therefore, cumulative effects on employment and payments to labor are expected to be significantly beneficial under FMP 2.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** No significant changes in product quality or utilization rate are expected under FMP 2.2 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, the continuation of this harvest strategy may hinder some of these improvements. Overall, increases in product quality and utilization are likely in the long-term though these improvements are not likely to result in significant cumulative effects under FMP 2.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly beneficial effects on excess capacity are expected under FMP 2.2 due to the increases in processing amounts.

- **Persistent Past Effects.** For details on persistent past effects see the beginning of 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Appendix F-8 Overcapacity Paper). The continuation of these programs in conjunction with increased TAC and retained harvests projected for FMP 2.2, significantly beneficial cumulative effects are expected.

Average Costs

- **Direct/Indirect Effects.** Significantly beneficial effects in average costs are expected under FMP 2.2 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described under FMP 2.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. As fixed costs are spread over a greater amount of throughput under FMP 2.2, they are likely to decrease significantly. Similar to FMP 1, closures do not change significantly from the baseline condition, therefore cumulative effects on average costs in the groundfish fisheries are expected to be significantly beneficial.

4.6.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under Alternative 2 (FMP 2.1 and FMP 2.2) are described below. The past/present effects on regions that participate in the groundfish fishery are described in Section 3.9 (Table 3.9-126) and below; these regions (illustrated in Figures 3.9-9 through 3.9-13) include:

- Aleutian Islands/Alaska Peninsula (comprised of the Aleutians East Borough and the Aleutians West Census Area, which includes the communities of Unalaska, Nikolski, Atka, Adak and the Pribilof Islands).

- Kodiak Island (Kodiak Island Borough, which includes the City of Kodiak).

- Southcentral Alaska (the Kenai Peninsula Borough, Matanuska-Susitna Borough, Municipality of Anchorage, and the Valdez-Cordova Census Area, which includes the PWS region).

- Southeast Alaska (from Yakutat Borough to Dixon Entrance).

- Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca).

- Oregon coast (Lincoln, Tillamook, and Clatsop counties).

This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. Due to the linkages of potential effects on regions that participate in the groundfish fishery to changes in harvest and processing levels under each of the policy alternatives and illustrative bookends, the direct and indirect effects of each alternative are based on an economic model that distributes potential effects to each of the participating regions. The indicators used to assess potential regional effects include the following:

- In-region Processing and Related Effects.
- Regionally Owned At-Sea Processors.
- Extra-regional Deliveries of regionally Owned Catcher Vessels.
- In-region Deliveries of regionally Owned Catcher Vessels.
- Total Direct, Indirect, and Induced Labor Income and FTE's.

As discussed earlier, these indicators also reflect changes in other important regional characteristics such as secondary economic activity associated with the support of fishing, state and municipal revenue generated by fishing, and indirectly population, to the extent that it is related to employment opportunities. For more information on the economic model used to assess direct and indirect regional effects (see the analysis for FMP 1 and Section 4.1.7 of the document).

Direct and Indirect Effects of FMP 2.1

Policy Alternative 2 removes or reduces some of the controls of the groundfish fishery, eliminates CDQ quotas, increases TAC, and represents a more aggressive harvest strategy. Under FMP 2.1, in general there is a strong net overall increase in fishery socioeconomic indicator values over baseline conditions for all regions. For example, total value of processing sales increases by about 52 percent over baseline conditions, while total processing and harvesting related income and employment increase by 53 and 56 percent, respectively, for all regions combined. These changes are driven to a large degree by the expansion of the pollock fishery, but essentially all values increase to some extent as a result of a more aggressive harvest strategy (higher TACs) and a removal of PSC limits. Elimination of the CDQ multi-species groundfish program also serves to increase overall TAC for relevant species for the non-CDQ portion of the fishery (while increases in the pollock fishery - and proportional increase of value of the CDQ portion of that fishery - would serve to offset losses from the discontinuation of the multi-species program to the CDQ region itself). Regional increases in the Alaska Peninsula and Aleutian Islands region are driven to a large degree by increased shoreplant activity (both pollock and Bering Sea cod), while Kodiak increases are driven by a mix of pollock, Pacific cod, and sablefish increases. The pattern for southcentral Alaska is similar to that seen for Kodiak while southeast changes are more directly attributable to sablefish by itself. The following subsections provide a region-by-region summary of change under FMP 2.1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 2.1, total in-region groundfish processing value would increase by 64 percent (with increases in both BSAI and GOA). In-region processing-associated labor income and FTE jobs would both increase by 64 percent. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would decline sharply in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional deliveries by regionally owned catcher vessels would increase by 40 percent and in-region deliveries would decrease, but by a less than significant amount. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 40 and 57 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs both would decrease by a less than significant amount, but for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. (Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes.) The total regional direct, indirect, and induced labor income would increase by about 62 percent and FTE employment would increase by about 62 percent under this FMP (from a base of $226 million in labor income and 4,796 FTEs). FMP 2.1 has beneficial impacts for the Alaska Peninsula and Aleutian Islands region, and a number of these impacts are considered significant on a local sector and a regional (and multiple community) basis.

Kodiak Island. Total in-region groundfish processing value would increase by 57 percent (with higher values for GOA; BSAI values are not a significant portion of the regional total). Associated labor income and FTE jobs would also increase by 57 percent. Regionally owned at-sea processing value would increase (with the vast majority of the increase attributable to changes in BSAI values), as would associated labor income and FTEs, but none of these increases are large enough to be considered significant. (In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total; labor income and FTEs distribution between these processing sectors follows a similar pattern.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 170 and 78 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 170 and 274 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 78 and 99 percent, respectively, but over a smaller base than seen for extra-regional deliveries. On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would increase by about 59 percent and FTE employment would increase by about 76 percent under this FMP (from a base of $65 million in labor income and 1,600 FTEs). FMP 2.1 has consistently beneficial impacts for the Kodiak Island region, and a number of these impacts are considered significant on a local sector and a regional (or at least the community of Kodiak) basis.

Southcentral Alaska. Total in-region groundfish processing value would increase by 104 percent (all attributable to GOA increases). Associated labor income and FTE jobs would also increase by 104 percent. Regionally owned at-sea processing value would increase by 78 percent (with increases in both BSAI values and GOA values), and associated labor income increasing by 78 percent and FTEs increasing by 79 percent. (In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 116 and 124 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 116 and 115 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 124 and 137 percent, respectively. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model clearly tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 103 percent and FTE employment would increase by about 107 percent (from a base of $23 million in labor income and 567 FTEs).

FMP 2.1 has consistently beneficial impacts for the southcentral Alaska region, and a number of these impacts are considered significant on a local sector basis. While some communities are likely to experience some noticeable benefits from these gains, on a regional basis (and in most involved communities), a relatively low level of groundfish dependency in local economies within this region tends to lessen what would otherwise appear to be a relatively large overall impact.

Southeast Alaska. Total in-region groundfish processing value would increase by 26 percent (all attributable to GOA decreases). Associated labor income and FTE jobs would also increase by 26 percent (but both are relatively low values). Regionally owned at-sea processing value would decrease by 49 percent (with decreases in BSAI values offset to a degree by increases in GOA values), and associated labor income and FTEs both decreasing by 49 percent. (In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase by about 57 percent and in-region deliveries by regionally owned catcher vessels would increase by 24 percent. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 51 and 58 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 24 and 25 percent, respectively. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase, but not by a large enough amount to be considered significant, while FTE employment would increase by about 20 percent (from a base of $34 million in labor income and 879 FTEs). FMP 2.1 has consistently beneficial impacts for the southeast Alaska region, and a number of these impacts are considered significant on a local sector basis. As was the case for the southcentral Alaska region for this FMP, while some communities are likely to experience some noticeable benefits from these gains, on a regional basis (and in most involved communities), a relatively low level of groundfish dependency in local economies within the southeast Alaska region tends to lessen what would otherwise appear to be a relatively large overall impact.

Washington inland waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase by 45 percent (with increases in both BSAI and GOA values, although GOA values are comparatively very small), and associated labor income and FTEs would increase by 43 and 49 percent, respectively. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 58 and 55 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 58 and 112 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 55 and 131 percent, respectively. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase by about 47 percent and FTE employment would also increase by about 47 percent (from a base of $557 million in labor income and 10,316 FTEs). FMP 2.1 has consistently beneficial impacts for the Washington inland waters region, and while a number of these impacts are considered significant on a local sector basis, none are likely to be significant on a community or regional basis as a result of the relative size of the communities and the size and diversity of the local economy.

Oregon coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase by 48 percent, and associated labor income and FTE jobs would increase 48 and 106 percent, respectively. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this FMP. The total regional direct, indirect, and induced labor income would increase by about 48 percent and FTE employment would increase by about 73 percent (from a base of $15 million in labor income and 318 FTEs). FMP 2.1 has consistently beneficial impacts for the Oregon coast region and while some of these impacts may be considered significant on a local sector basis, none are considered significant on a community or regional basis due to a relatively low level of economic dependency on the groundfish fishery.

Cumulative Effects of FMP 2.1

See Table 4.6-6 for a summary of the cumulative effects on regions and communities under FMP 2.1.

<u>In-Region Processing and Related Effects</u>

- **Direct/Indirect Effects.** For FMP 2.1, direct/indirect effects are considered significantly beneficial for the Alaska Peninsula/Aleutian Islands, Kodiak Island, southcentral Alaska, and southeast Alaska regions. Direct/indirect effects are generally insignificant for the Washington inland waters, and Oregon coast regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1, cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant, although for different reasons in different regions. The influence of external factors is adverse for many of the in-region processors based in Alaska and their associated regions. Trends in multi-species fisheries and other sources of municipal and state revenue, primarily due to the continued crab closures, downturn in salmon and reductions in state and municipal revenue, result in adverse effects on in-region processing and municipal revenue. These adverse external effects are offset by significant increases in Alaska in-region processing, resulting in a finding of insignificant cumulative effect. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution, resulting in a finding of insignificant cumulative effect.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** Under FMP 2.1, direct/indirect effects are considered significantly beneficial for the southcentral Alaska and Washington inland waters regions. Direct/indirect effects are generally insignificant for the Alaska Peninsula/Aleutian Islands, Kodiak Island, and Oregon coast regions, and are significantly adverse for the southeast Alaska region.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1, cumulative effects on regionally owned at-sea processing and on related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. While direct/indirect effects are beneficial for southcentral Alaska and Washington inland waters regions, reasonably foreseeable external effects will not contribute much to cumulative effects, particularly given the size and diversity of the regional economies. Direct/indirect effects are insignificant in Kodiak Island, where most of the Alaska at-sea processor fleet is based. As indicated previously, with a more diversified economy and population base, cumulative effects in Kodiak Island will be adverse due to external factors, but cumulatively insignificant.

Extra-regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 2.1, direct and indirect effects are significantly beneficial for all six regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1, significantly beneficial effects for all regions contribute to regional economies. However, given the size and diversity of some regional economies, and the adverse nature of external effects related to other fisheries and revenue sharing in the Alaska regions that offset benefits, cumulative effects are insignificant for all regions.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 2.1, direct/indirect effects are significantly beneficial for Kodiak Island, southcentral Alaska, southeast Alaska, and Washington inland waters; effects are insignificant for the Alaska Peninsula/Aleutian Islands, and Oregon coast regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1 the direct/indirect effects range from beneficial to insignificant. However, given the size and diversity of some regional economies, and the adverse nature of external effects related to other fisheries and revenue sharing in the Alaska regions that offset benefits, cumulative effects are insignificant for all regions.

Total Direct, Indirect, and Induced Labor Income and FTEs

- **Direct/Indirect Effects.** Under FMP 2.1, direct/indirect effects on labor income and employment increase and are significantly beneficial for all regions, except for southeast Alaska, where the increase is insignificant.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1 direct/indirect effects on labor income and employment are significantly beneficial for all regions. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Trends in other fisheries (particularly salmon) and reductions in municipal revenue decrease labor income and employment and offset these benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are beneficial, but insignificant in all regions.

Direct/Indirect Effects of FMP 2.2

Under FMP 2.2, in general fishery socioeconomic indicators fall in a range between the values seen under FMP 1 and those seen under FMP 2.1. Indicators at the most aggregated level are greater than baseline conditions for all regions. For example, total value of processing sales increases by about 22 percent over baseline conditions, while total processing and harvesting related income and employment increase by 22 and 19 percent, respectively, for all regions combined. Pollock and Pacific cod values are up overall, but the effects of this increase are most pronounced in the Alaska Peninsula and Aleutian Islands and Kodiak regions. Sablefish and rockfish increases play a large proportional role in the overall increases seen in the southcentral and southeast Alaska regions. One caveat to the data that appear in the regional summaries for this FMP, however, is that the model tends to overstate the increases seen in southcentral and understate the increases in southeast due to apportionment difficulties, so regional variations between these two should be treated with caution. (Overall values for the two regions combined are apparently accurate; it is the split between the two that is problematic.) As with FMP 2.1, essentially all socioeconomic indicator values increase to some extent as a result of a more aggressive harvest strategy compared to baseline conditions. Unlike FMP2.1, however, the CDQ multi-species groundfish program continues unchanged from baseline conditions under FMP 2.2. The following subsections provide a region-by-region summary of change under FMP 2.2 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 2.2, total in-region groundfish processing value would increase by 24 percent (with increases in both BSAI and GOA values). In-region processing associated labor income and FTE jobs would also increase by 24 percent. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would increase in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional deliveries by regionally owned catcher vessels would remain the same and in-region deliveries would decrease, but by an amount that is considered less than significant. Catcher vessel payments to labor would remain the same and FTE jobs associated with extra-regional deliveries would decrease, but not to a significant degree. For in-region deliveries, catcher vessel payments to labor and FTEs would also decrease (by a less than significant amount), but for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. (Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes.) The total regional direct, indirect, and induced labor income would increase by about 24 percent and FTE employment would increase by 23 percent under this FMP (from a base of $226 million in labor income and 4,796 FTEs). FMP 2.2 would result in beneficial impacts for the Alaska Peninsula and Aleutian Islands region, and a number of these impacts would be considered significant on a local sector and a regional (and multiple community) basis.

Kodiak Island. Total in-region groundfish processing value would increase (with high values for both GOA and BSAI; BSAI values are not a significant portion of the regional total) as would associated labor income and FTE jobs, but these increases would not rise to the level of significance. Regionally owned at-sea processing value would increase by 25 percent (with the vast majority of the increase attributable to changes in BSAI values), and associated labor income and FTEs would increase by 24 and 25 percent, respectively. (In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total; labor income and FTEs distribution between these processing sectors follow a similar pattern.) The value of extra-regional deliveries by regionally owned catcher vessels would increase by 32 percent, and while in-region deliveries would also increase, this increase would not be significant. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 32 and 38 percent, respectively. For in-region deliveries, catcher vessel payments to labor would increase and FTEs would decrease, but neither change would be significant (and would be over a smaller base than seen for extra-regional deliveries). On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would increase as would FTE employment under this FMP (from a base of $66 million in labor income and 1,600 FTEs), but these changes would not rise to the level of significance. FMP 2.2 would generally result in beneficial impacts for the Kodiak Island region, and a number of these impacts would be considered significant on a local sector basis, but it would appear that the impacts, while beneficial, would be less than significant on a regional (or community of Kodiak) basis.

Southcentral Alaska. Total in-region groundfish processing value would increase by 34 percent (all attributable to GOA increases). Associated labor income and FTE jobs would also increase by 34 percent. Regionally owned at-sea processing value would increase by 34 percent (with relatively large increases in BSAI values and smaller increases in GOA values), and associated labor income and FTEs both increasing by 34 and 35 percent, respectively. (In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase, but by less than a significant amount, while in-region deliveries would rise by 41 percent. Catcher vessel payments to labor associated with extra-regional deliveries would increase and FTE jobs would decrease, but neither change would be significant. For in-region deliveries, catcher vessel payments to labor and FTEs would increase, but this change would also be less than significant. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 31 percent and FTE employment would increase 22 percent (from a base of $23 million in labor income and 567 FTEs). FMP 2.2 would generally result in beneficial impacts for the southcentral Alaska region, and some of this rise to the level of significance on a local sector basis. As noted in the FMP 2.1 discussion, however, there are indications that the model overstates gains attributed to the southcentral and understates gains to the southeast Alaska region. Further, given the economic diversity of the involved southcentral communities and the relatively low level of groundfish dependency in the local economies, impacts that appear significant on a sector basis are not likely to be significant on a regional or even a community basis, with very few possible exceptions.

Southeast Alaska. Total in-region groundfish processing value would decrease by an insignificant amount (all attributable to GOA decreases), as would associated labor income and FTE jobs (but both are relatively low values). Regionally owned at-sea processing value would increase by 25 percent (with increases in BSAI values and GOA values), and associated labor income and FTEs both increasing by 25 percent. (In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase by 22 percent, while in-region deliveries would decrease by a less than significant amount. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 22 and 23 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would about the same. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income and associated FTEs would all increase (from a base of $34 million in labor income and 879 FTEs), but these changes would not rise to the level of significance. FMP 2.2 would have generally beneficial impacts on the southeast Alaska region, and these impacts would be significant for some local sectors, regional level impacts resulting from this FMP are unlikely to be significant given the diversity of the local economies and the relative lack of dependence on the groundfish fishery.

Washington inland waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase by 22 percent (with increases in both BSAI and GOA values, although GOA values are comparatively very small), and associated labor income and FTEs would increase by 22 and 23 percent, respectively. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 24 and 21 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 24 and 23 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 21 and 29 percent, respectively. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase by about 22 percent and FTE employment would increase, but by a less than significant amount (from a base of $557 million in labor income and 10,316 FTEs). FMP 2.2 would result in significantly beneficial impacts to local sectors in the Washington inland waters region, but these impacts would not rise to the level of significance on a regional or a community of Seattle basis, given the scale of the local economy and the relative lack of dependency on the groundfish fishery.

Oregon coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase by 22 percent, and associated labor income and FTE jobs would increase 22 and 28 percent, respectively. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this FMP. The total regional direct, indirect, and induced labor income would increase by about 22 percent and FTE employment would increase by about 24 percent (from a base of $15 million in labor income and 318 FTEs). FMP 2.2 would result in significantly beneficial impacts to the local catcher vessel sector in the Oregon coast region, but these impacts would not be significant on a community or regional basis, given the scale and diversity of local economies and the low degree of dependency on the groundfish fishery.

Cumulative Effects of FMP 2.2

See Table 4.6-6 for a summary of the cumulative effects on regions and communities under FMP 2.1 and FMP 2.2.

In-Region Processing and Related Effects

- **Direct/Indirect Effects.** For FMP 2.2, direct/indirect effects are considered significantly beneficial for the Alaska Peninsula/Aleutian Islands and southcentral Alaska regions. Direct/indirect effects are generally insignificant for the Kodiak Island, southeast Alaska, Washington inland waters, and Oregon coast regions. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, cumulative effects fall between FMP 2.1 and FMP 1. Within the four Alaska regions, benefits from increased processing are offset by the adverse external effects in other fisheries, economic development and state and municipal revenue. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution. Cumulative effects for all six regions are cumulatively insignificant.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** For FMP 2.2, direct/indirect effects are considered significantly beneficial for the Kodiak Island, southcentral Alaska, southeast Alaska, and Washington inland waters regions. Direct/indirect effects are generally insignificant for the Alaska Peninsula/Aleutian Islands and Oregon coast regions. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for In-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, direct/indirect effects are beneficial for four regions and insignificant for the other two regions. Based on direct/indirect benefits and economic diversity, adverse external factors in Alaska regions are offset, and cumulative effects are insignificant.

<u>Extra-regional Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects.** Under FMP 2.2, direct and indirect effects are significantly beneficial for the Washington inland waters, Kodiak Island, southeast Alaska, and Oregon coast regions and insignificant for southcentral Alaska and Alaska Peninsula/ Aleutian Islands. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, cumulative effects are insignificant for all regions, where direct/indirect benefits generally offset adverse external factors in Alaska regions. In southeast Alaska, direct/indirect effects are insignificant, and adverse external effects are likely to result in adverse but insignificant cumulative effects.

<u>In-Region Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects.** Under FMP 2.2, direct/indirect effects are significantly beneficial for southcentral Alaska and Washington inland waters and are insignificant for the Alaska Peninsula/Aleutian Islands, Kodiak Island, southeast Alaska, and Oregon coast regions. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, direct/indirect effects of in-region deliveries range from beneficial to insignificant. However, given the size and diversity of some regional economies, and the adverse nature of external effects related to other fisheries and revenue sharing in the Alaska regions that offset benefits, cumulative effects are insignificant for all regions.

Total Direct, Indirect, and Induced Labor Income and FTEs

- **Direct/Indirect Effects.** Under FMP 2.2, direct/indirect effects on labor income and employment increase and are significantly beneficial for Alaska Peninsula/Aleutian Islands, southcentral Alaska, Washington inland waters, and Oregon coast regions. In Kodiak Island and southeast Alaska the increase is insignificant. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, employment increases in all regions, but not necessarily in a significant manner. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Trends in other fisheries (particularly salmon) and reductions on municipal revenue, decrease labor income and employment offset these benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are beneficial, but insignificant in all regions.

4.6.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described below. The past/present effects on CDQ are described in Section 3.9 (Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is allocation of catch to CDQ groups. It should be noted that allocation reflects potential revenue to CDQ groups, and indirectly the potential funds that are available for approved economic development activities in CDQ communities.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Community Development Quota Related Impacts Under FMP 2.1

Under FMP 2.1, the fishery would be returned to an open-access scenario, where many time/area closures, gear restrictions, and PSC restrictions are repealed. The Federally mandated effort limitation program enacted under the American Fisheries Act, with its CDQ allocation for pollock, would remain in place, and the CDQ Program, mandated by the MSA, would be modified to allocate only a percentage of the BSAI TAC for pollock to the CDQ Program. All other effort limitation programs including, but not limited to, the multi-species CDQ groundfish program, would be repealed. The multi-species groundfish CDQ program has steadily grown in relative importance since its inception, and in 2000 it accounted for approximately one-tenth of all CDQ royalties. Due to the loss of revenue and other economic and employment opportunities under this FMP, repeal of the multi-species program would generate adverse impacts to CDQ groups. However, under FMP 2.1, the pollock fishery would expand substantially over baseline conditions, so it is assumed that the pollock CDQ program would proportionally expand with the rest of that fishery. In terms of net change, this expansion would offset the losses incurred as a result of the discontinuation of the multi-species program, but it is the case that losses and gains would not be evenly distributed among CDQ groups due to differential reliance on the various species under the overall CDQ program (and within the multi-species program in particular). As a result, the significance of direct/indirect effects are unknown.

Community Development Quota Related Impacts Under FMP 2.2

As noted above, under FMP 2.2, direct/indirect effects would be similar to FMP 1. The existing level of BSAI groundfish quota would continue to be apportioned under the CDQ program to the 65 eligible western Alaska communities through the established CDQ groups. It is assumed that the multi-species CDQ program and quotas would continue as well. Under FMP 2.2, TAC increases, so no adverse impacts to the CDQ program or regions are anticipated.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects on CDQ for FMP 2.1 and FMP 2.2 are summarized on Table 4.6-6.

CDQ Allocations

- **Direct/Indirect Effects.** Under FMP 2.1, the direct/indirect effects of the groundfish fisheries on the CDQ program are unknown. Under FMP 2.2, the direct/indirect effects of the groundfish fisheries on the CDQ program are insignificant.

- **Persistent Past Effects.** The past/present effects on the CDQ program for groundfish fisheries include establishment of CDQ program; FMP amendments that further added or defined CDQ in 1992, 1995, 1996, and 1998; establishment of multi-species CDQ programs, and persistent limitations on economic development and associated employment activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1, the potential cumulative effects for the CDQ program are unknown. There is some level of adverse cumulative effects to the CDQ program but significance is unknown. Under this FMP the fishery would be returned to an open access scenario creating increased competition. The multi-species CDQ groundfish program would be repealed, and the overall groundfish CDQ program would be scaled back to only a single species, pollock. Discontinuation of the multi-species program would be an adverse impact, but given the increase in pollock TAC under this FMP, the CDQ return on pollock is expected to increase resulting in a beneficial impact. However, the losses and gains would not be evenly distributed among CDQ groups due to the differential reliance on various species. Under FMP 2.2, the cumulative effect on the CDQ program is insignificant. With guaranteed CDQ shares through the CDQ program, no significantly adverse cumulative impacts to the CDQ program are expected.

4.6.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described below. The past/present effects on subsistence are described in 3.9 (including a summary in Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are other fisheries such as foreign JV, domestic, and state-managed fisheries, other economic development activities, sport and personal use, and long-term climate change and regime shift.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Potential impacts to subsistence fall into four main categories: subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon in western Alaska and bycatch in the groundfish fisheries, and indirect impacts on other subsistence activities, including loss of income that would be otherwise directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would be otherwise be available for joint production opportunities.

Under FMP 2.1, increases in the commercial fishery are anticipated but would not result in significantly adverse direct/indirect impacts to baseline subsistence groundfish fishing conditions. This FMP would have a conditionally significant adverse impact on Steller sea lion subsistence activities or take over baseline conditions. Although Steller sea lion protection measures are retained, questions remain about the impact of reduced pelagic forage availability as noted in earlier sections. If these issues result in significant Steller population decline, a significantly adverse impact to Steller sea lion subsistence activities could result. Under this FMP bookend, salmon bycatch may be expected to increase due to the repeal of PSC restrictions. This would create a conditionally significant adverse impact on subsistence salmon fisheries, with the conditions for significance being met if the resulting level of increased bycatch results in significant decreases in salmon returns to subsistence fishery areas. Catcher vessel activity and labor income are anticipated to increase under this FMP; therefore no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

Under FMP 2.2, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. There is also no indication that this FMP would have an adverse impact on Steller sea lion subsistence activities or take over baseline conditions. (Although under this FMP a more aggressive harvest policy is implemented, Steller sea lion protection measures are retained so it is assumed there are no adverse impacts to that species, but there are still concerns with pelagic forage availability as noted earlier). Salmon bycatch would essentially remain the same as under baseline conditions and is determined to have no significantly adverse effect on the return of salmon to western Alaska rivers; therefore no significantly adverse impacts to subsistence salmon fisheries are expected to result. Catcher vessel activity and labor income are anticipated to increase under this FMP; therefore no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

Cumulative Effects of FMP 2.1 and FMP 2.2

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described above. The past/present effects on subsistence are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. Representative indicators used in this analysis are the same as those used in the direct/indirect analysis and include subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon, and indirect impacts on other subsistence activities (Table 4.6-6). For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Subsistence Use of Groundfish

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. The effects of FMPs 2.1 and 2.2 are insignificant.

- **Persistent Past Effects.** Foreign JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries and long-term climate change have a potential to adversely contribute to subsistence use of the groundfish fisheries. Economic development and sport and personal use are not likely to adversely contribute to subsistence use of the groundfish fisheries. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1 and FMP 2.2, the cumulative effects for subsistence use of groundfish are insignificant. The external impacts of other fisheries, economic development activities, and sport and personal use of groundfish are not likely to contribute to significantly adverse cumulative effects on the groundfish fisheries. Other state-managed fisheries could have adverse impacts to the subsistence use of groundfish due to the direct competition for the same species, but are not considered to be significant. The long-term climate change could adversely affect groundfish stocks.

Subsistence use of Steller Sea Lions

- **Direct/Indirect Effects.** Under FMP 2.1, there would be a conditionally significant adverse impact on Steller sea lion subsistence activities or take compared to baseline conditions. Although Steller sea lion protection measures are retained, questions remain about the impact of reduced pelagic forage availability as noted in earlier sections. If these issues result in significant Steller population decline, a significantly adverse impact to Steller sea lion subsistence activities could result. Under FMP 2.2, effects would be similar to FMP 1 and there would be insignificant effects on Steller sea lion subsistence activities or take over baseline conditions.

- **Persistent Past Effects.** The past/present effects on subsistence use of Steller sea lions include the following: a long-term decline in population of Steller sea lions due to a number of factors; a long-term decline in relative importance of marine mammals in local diets; commercial groundfish fishing taking prey species utilized by Steller sea lions; and Steller sea lion protection measures designed to assist in population recovery instituted in 2000. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, economic development, and long-term climate change have a potential to adversely contribute to Steller sea lions subsistence activities. Sport and personal use is not likely to adversely contribute to subsistence use of Steller sea lions. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMPs 2.1, a conditionally significant adverse cumulative effect is identified for subsistence use of Steller sea lions. The adverse cumulative effects on subsistence use of Steller sea lions all reduce the availability of Steller sea lions for subsistence use. They include the combined take for subsistence in other fisheries and in the groundfish fisheries and the reduced availability resulting from the continuing endangered status and long-term decline in abundance. Under FMP 2.2, the cumulative effect for subsistence use of Steller sea lions is insignificant. The adverse cumulative effects are not sufficient to significantly impact subsistence.

<u>Subsistence Use of Western Alaskan Salmon and Bycatch in the Groundfish Fishery</u>

- **Direct/Indirect Effects.** Under FMP 2.1, salmon bycatch may be expected to increase due to the repeal of prohibited species catch restrictions. This would create a conditionally significant adverse impact on subsistence salmon fisheries, with the conditions for significance being met if the resulting level of increased bycatch results in significant decreases in salmon returns to subsistence fishery areas. Under FMP 2.2, salmon bycatch would essentially remain the same as under baseline conditions and is determined to have insignificant effects.

- **Persistent Past Effects.** The past/present effects on subsistence use of salmon include the following: utilization for subsistence since pre-contact times; and Area M closures implemented to decrease intercept of salmon; these factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities and long-term climate change and regime shift could all adversely contribute to salmon subsistence activities. Sport and personal use is not likely to adversely contribute to salmon subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1, a conditionally significant adverse cumulative effect is identified for subsistence use of salmon. Given the removal of the prohibited species catch caps, poor stock status of salmon runs in western Alaska and the combined effects of groundfish and state fisheries bycatch potential in BSAI and GOA, the availability of depressed salmon stocks for subsistence could be significantly impacted. Under FMP 2.2, insignificant cumulative effects are identified as the conditions are not expected to change from FMP 1.

Indirect Impacts on Other Subsistence Activities (Income and Joint Production Opportunities)

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, catcher vessel activity and labor income are anticipated to be neutral or increase,; therefore insignificant effects to subsistence through a decline in income or joint production opportunities are expected to occur.

- **Persistent Past Effects.** The past/present effects on the indirect impacts on other subsistence activities include joint production as a part of local groundfish and other commercial fishery development from the outset; and income from fishing used for investment in subsistence is similar to use of income from other activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shift could all adversely or beneficially contribute to indirect subsistence activities. Sport and personal use is not likely to adversely contribute to indirect impacts on other subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1 and FMP 2.2, an insignificant cumulative effect is identified for indirect subsistence use. Under FMP 2.1 the increased opportunities for joint production are beneficial but not significant, offset by trends in other fisheries such as salmon. Under FMP 2.2 adverse cumulative effects are similar to the baseline and are not enough to have significant impacts on subsistence. Income catcher vessel activity, and joint production opportunities are not expected to be effected adversely. However, the external impacts of other fisheries, other economic development activities, and long-term climate change and regime shift could potentially contribute adversely to the indirect subsistence use.

4.6.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under Alternative 2 (FMP 2.1 and FMP 2.2) are described below. The past/present effects on Environmental Justice are described in Section 3.9 (and are summarized in Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The external effects used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, other sources of municipal and state revenue, and long-term climate change and regime shift.

Direct/Indirect Effects of FMP 2.1

Potential impacts that drive Environmental Justice issues include employment/municipal revenue and taxes in communities with significant percentages of special populations (Alaska Native and minority processing workforce); revenue to Alaska Native-owned catcher vessels; revenue to Alaska Native-owned catcher processors; subsistence activities associated with groundfish, Steller sea lion, and salmon; and the loss of income from fishing that would be otherwise directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. The regions that could experience potential impacts include the Alaska Peninsula and Aleutian Islands, Kodiak Island, southcentral Alaska, southeast Alaska, Washington inland waters, Oregon coast, the CDQ regions, and western Alaska communities that harvest salmon for subsistence purposes.

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 2,194 jobs; therefore, insignificant environmental justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $758 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated environmental justice impacts would occur. In this region the ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under FMP 2.1, the total value of catcher vessel operations would increase as would corresponding labor income and employment; therefore, no associated Environmental Justice impacts would result.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 324 jobs; therefore, insignificant Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $127 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the City and the Kodiak Island Borough, but given local and regional demographics, this change is not likely to be relevant as an Environmental Justice issue. Ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under FMP 2.1, the total value of catcher vessel operations would increase as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be connected to Environmental Justice issues.

Southcentral Alaska. As described in existing conditions, Environmental Justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that environmental justice issues will be associated with any employment change. In general, under FMP 2.1 overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns. Similarly, processing value increases, as do catcher vessel associated values, but these changes are not tied to Environmental Justice concerns. The direct/indirect effects on environmental justice are therefore, insignificant.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall environmental justice concerns appear not to apply in this region. In general, under FMP 2.1 overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to Environmental Justice concerns. Similarly, processing value increases and analogous catcher vessel associated values increase, but this change is not associated with environmental justice concerns. The direct/indirect effects on Environmental Justice are therefore, insignificant.

Washington inland waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, Environmental Justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under FMP 2.1, at-sea processing labor income increases by 43 percent and FTEs increase by 49 percent, so there are insignificant Environmental Justice impacts associated with this change.

Oregon coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under FMP 2.1 overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not linked to Environmental Justice concerns. The direct/indirect effects on Environmental Justice are therefore, insignificant.

CDQ region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve Environmental Justice concerns. As described in Section 4.6.9.3, the CDQ program and region would experience adverse impacts under FMP 2.1 from the elimination of the multi-species CDQ program. However, while these decreases would be offset by increases in returns from the pollock CDQ allocation for an overall net gain, this offset will not be uniform across CDQ groups.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. Subsistence activities where there are potential Environmental Justice issues under FMP 2.1 include the harvest of Steller sea lion (primarily and activity in the Alaska Peninsula/Aleutian Islands region), and salmon (primarily an issue in western Alaska, where poor runs have adversely affected subsistence harvests). Increased TAC and reduction in or elimination of measures to limit salmon by-catch would potentially create significantly adverse Environment Justice issues for communities in the Alaska Peninsula/Aleutian Islands region that harvest Steller Sea lions, and in western Alaska communities that rely on salmon.

Under FMP 2.1, increased opportunities related to income and joint production indicate that there are insignificant impacts on Environmental Justice issues.

Cumulative Effects of FMP 2.1

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above. The past/present effects on Environmental Justice Issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicators used in this analysis are the same as those used in the direct/indirect analysis.

- **Direct/Indirect Effects.** Under this FMP, direct/indirect impacts are insignificant as no changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline. However, conditionally significant adverse effects on western Alaskan communities due to increased salmon bycatch under FMP 2.1 are possible.

- **Persistent Past Effects.** Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, other sources of municipal/state revenue, and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1, an insignificant cumulative effect is identified for Environmental Justice, with the exception of a conditionally significant adverse effect on salmon subsistence in western Alaska. In general, benefits, including municipal revenues, would increase for both Alaska Native and non-Native communities participating in groundfish fisheries, but overall cumulative effects are insignificant. Increased joint production opportunities for subsistence are beneficial effects, but are cumulatively insignificant. The multi-species groundfish CDQ program would be eliminated under FMP 2.1, creating some level of adverse cumulative effects, but these effects would be largely offset by increased returns under the pollock CDQ program. Under FMP 2.1 salmon bycatch could be expected to increase due to the repeal of prohibited species catch restrictions. This could create conditionally significant adverse cumulative effects to subsistence fishery areas. Adverse cumulative effects to Steller sea lion subsistence activities could result but are not expected to be significant.

Direct/Indirect Effects of FMP 2.2

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 827 jobs; therefore, no environmental justice associated impacts would result. Total in-region groundfish processing value would increase from $464 million to $575 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated environmental justice impacts would occur. In this region the ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under FMP 2.2, the total value of catcher vessel operations would decrease as would corresponding labor income and employment; therefore, an apparent Environmental Justice impact may occur, but it is likely that this apparent decline is at least in part an artifact of the output model's limitation on the ability to adequately assign western Gulf of Alaska catch to the region rather than an actual decline.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would decrease over baseline conditions by about 37 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $86 million. The increased in-region processing value would provide higher municipal revenue and taxes to the City and the Kodiak Island Borough, and given local and regional demographics, this is not likely to be an Environmental Justice issue. Ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under FMP 2.2, the total value of catcher vessel operations would increase as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be relevant as an Environmental Justice issue.

Southcentral Alaska. As described in existing conditions, environmental justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that Environmental Justice issues will be associated with any employment change. In general, under FMP 2.2 overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns. Similarly, processing value increases and catcher vessel associated values increase, but these changes are not tied to Environmental Justice concerns. See Table 3.9-126 for a summary of the direct/indirect effects on environmental justice in the southcentral Alaska region and communities.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall Environmental Justice concerns appear not to apply in this region. In general, under FMP 2.2 overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to Environmental Justice concerns. Similarly, processing value decreases, but this change is not associated with Environmental Justice concerns.

Washington inland waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, Environmental Justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under FMP 2.2, at-sea processing labor income and FTEs increase by 22 and 23 percent, respectively, so there are no Environmental Justice impacts associated with this change.

Oregon coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under FMP 2.2 overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not considered relevant to Environmental Justice concerns.

CDQ region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve Environmental Justice concerns. As described in Section 4.6.9.3, the CDQ program and region would experience impacts under FMP 2.2 similar to those seen under FMP 1, with no significantly adverse impacts foreseen.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. As described above, adverse impacts to subsistence activities are not foreseen under FMP 2.2 (with the possible exception to Steller sea lion population dynamics), therefore no associated Environmental Justice impacts are anticipated.

Cumulative Effects of FMP 2.2

The predicted direct and indirect effects of the groundfish fishery under FMP 2.2 are described above. The past/present effects on Environmental Justice Issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicators used in this analysis is the same as that used in the direct/indirect analysis (Table 4.6-6).

- **Direct/Indirect Effects.** Under this FMP, direct/indirect impacts range from beneficial to adverse, but any changes in the commercial fishery would result in insignificant effects to baseline, with the exception of conditionally significant adverse effects on western Alaskan communities due to increased salmon bycatch under FMP 2.2. However, the overall effects are still insignificant.

- **Persistent Past Effects.** Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, other sources of municipal/state revenue, and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.2, an insignificant cumulative effect is identified for Environmental Justice. In general, benefits, including municipal revenues, would increase for both Alaska Native and non-Native communities participating in groundfish fisheries, but cumulative effects are insignificant. Increased joint production opportunities for subsistence are beneficial effects, but are cumulatively insignificant. Salmon bycatch could have adverse cumulative effects but not enough to be significant. Significantly adverse cumulative effects to Steller sea lion subsistence activities could result but not enough to be significant.

4.6.9.6 Market Channels and Benefits to U.S. Consumers

The predicted direct and indirect effects of the groundfish fishery under the FMP 2.1 and FMP 2.2 are described below. The past/present effects on Market Channels and Benefits to U.S. Consumers are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. Representative indicators used in this analysis include product quantity, product year-round availability, product quality, and product diversity on Market Channels and Benefits to U.S. Consumers activities.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

FMP 2.1 is expected to have an insignificant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. FMP 2.1 will result in the increased production of most groundfish products. An estimate of the final market value of BSAI and GOA seafood products is not available; however, it would be substantially greater than $2.2 billion, the projected 5-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing under FMP 2.1. This product value mean is 57 percent greater than the comparative baseline. While most products produced from Alaska groundfish enter an international market, some of the consumer benefits of this increased production are expected to accrue to American seafood consumers. The price elasticity of demand for groundfish products is fairly high in the U.S. market, but assuming that the demand for groundfish products is not perfectly elastic, the expected increase in production could result in lower prices and a gain of consumer surplus (i.e., net benefits) to the American public. The magnitude of that gain will depend on price elasticities that are not quantifiable at this time and on the degree to which production is shifted toward or away from export markets. However, it is unlikely that the gain in consumer surplus will be significant. Moreover, these potential consumer benefits may be partially offset by the expected decrease in quality of some groundfish products that results from the intensification of the race for fish occurring under this FMP.

FMP 2.2 is expected to have an insignificant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Under FMP 2.2 the BSAI and GOA groundfish fisheries are expected to continue to provide high and relatively stable levels of seafood products to domestic and foreign markets. An estimate of the final market value of BSAI and GOA seafood products is not available; however, it would be substantially greater than $1.7 billion, the projected 5-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing under FMP 2.2. This product value mean is 26 percent greater than the comparative baseline. While most products produced from Alaska groundfish enter an international market, some of the consumer benefits of this increased production are expected to accrue to American seafood consumers. The price elasticity of demand for groundfish products is fairly high in the U.S. market, but assuming that the demand for groundfish products is not perfectly elastic, the expected increase in production could result in lower prices and a gain of consumer surplus (i.e., net benefits) to the American public. However, it is unlikely that the gain in consumer surplus will be significant.

Cumulative Effects of FMP 2.1 and FMP 2.2

For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Market Channels and Benefits to U.S. consumers

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, increases in benefits to U.S. consumers of groundfish products are expected to occur but are insignificant.

- **Persistent Past Effects.** These effects on benefits to U.S. consumers of groundfish products include: Alaska Seafood Marketing Institute product promotion activities, research and public awareness regarding the health benefits of seafood consumption, aquaculture development increasing overall availability and demand for seafood products, and changes in processing technology increasing seafood quality.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable effects include other fisheries (supply of product) and long-term climate change and regime shift. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1 and FMP 2.2, an insignificant cumulative effect is identified for benefits to U.S. consumers of groundfish products. FMP 2.1 will result in the increased production of most groundfish products with the potential decrease in quality of some groundfish products. FMP 2.2 will result in an expected increase in production with the potential to result in lower prices and a gain of consumer surplus. However, it is unlikely that the gain in consumer surplus will be significant. The external impacts of other fisheries have the potential to contribute adversely or beneficially to the U.S. consumers of groundfish products and the groundfish market channels. However, the wholesale groundfish product value in conjunction with products from other fisheries is not expected to change benefits to U.S. consumers. The long-term climate change and regime shift could adversely effect availability for market channels due to the natural fluctuations in groundfish stocks.

4.6.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (Including Non-Consumptive and Non-Use Benefits)

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described below. Benefits derived from marine ecosystems and associated species are used as a surrogate to evaluate non-consumptive and non-use benefits. The past/present effects on non-consumptive and non-use Benefits to U.S. general public are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits).

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Under FMP 2.1, the Bering Sea and GOA marine ecosystems and species associated with them are expected to generate significantly lower levels of some benefits relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 2.1 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.6.10 of the Draft Programmatic SEIS.

As described in Section 3.9.7, the Bering Sea and GOA marine ecosystems and species associated with them provide a broad range of benefits to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value the public places on protecting ecological conditions, Section 3.9.7 provides a qualitative discussion of possible benefits provided by the Bering Sea and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people may not directly interact with the Bering Sea and GOA marine ecosystems and the various species associated with them but derive satisfaction from knowing that the structure and function of these ecosystems are protected.

The focus in this analysis is on the direct and indirect effects of the alternatives on ecosystem benefits other than those that accrue to members of society who make a living harvesting, processing and distributing BSAI and GOA groundfish products or who purchase and consume these products. The direct and indirect effects of the alternatives on firms and communities that derive value from the commercial harvest and processing of groundfish are described elsewhere in the Draft Programmatic SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of the Draft Programmatic SEIS.

The value people assign to those marine ecosystem benefits that are unrelated to commercial groundfish fisheries are thought to be considerable. For example, the value of protecting the Steller sea lion alone may be substantial. As discussed in Section 3.9.7, a contingent valuation study suggests that there is a significant willingness to pay on the part of the American public for an expanded Federal Steller sea lion recovery program. At this time, however, there is insufficient information to provide a comprehensive measure of the benefits derived from these ecosystems and the various species associated with them.

A primary outcome of this FMP bookend is a large increase in the harvest levels that occur in most groundfish fisheries relative to the comparative baseline. In addition, time/area closures, gear restrictions, and bycatch restrictions would be repealed. As discussed in Section 4.6.10, the increase in harvest levels and elimination of measures are expected to have significantly or conditionally significant adverse consequences for predator-prey relationships, energy flow and balance, and diversity. In turn, these adverse effects on the Bering Sea and GOA marine ecosystems and associated species are expected to lead to a significant reduction in the levels of some of the benefits these ecosystems and species provide.

FMP 2.2 resembles FMP 2.1 in that it also represents a more aggressive harvest strategy. While some of the current measures that reduce the potential adverse effects of fishing on the Bering Sea and GOA marine ecosystems and species associated with them would remain in place under FMP 2.2, the increased harvest levels that occur under this FMP are predicted to have a significantly or conditionally significant adverse impact on predator-prey relationships for some marine mammals (Section 4.6.10). Consequently, the levels of some of the benefits these marine ecosystems and species provide may be lower than the comparative baseline. The significance of this effect is conditional, as both the intensity of the effect and the probability of its occurrence are uncertain.

Cumulative Effects of FMP 2.1 and FMP 2.2

For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Benefits derived from Marine Ecosystems and Associated Species

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2 the risks of adverse effects that the Alaska groundfish fishery could have on marine ecosystems are increased. FMP 2.1 represents a more aggressive harvest strategy, as does FMP 2.2 but to a lesser extent. This is predicted to have a conditionally significant adverse impact on the levels of some of the benefits these ecosystems and associated species generate.

- **Persistent Past Effects.** Persistent past effects on non-consumptive and non-use benefits) include: an increase in public awareness of marine ecosystems; increased participation in recreational fishing and eco-tourism activities; and public perceptions with regard to fisheries management. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects include other fisheries, and long-term climate change and regime shifts. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under both FMP 2.1 and FMP 2.2, a conditionally significant adverse cumulative effect is identified for benefits to the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits). The external effects of other fisheries have the potential to contribute adversely to benefits the public derives from marine ecosystems and associated species. FMP 2.1 and FMP 2.2 management measures could accelerate the introduction of non-native species, effect a change in pelagic forage availability, spacial and temporal concentration of fishery impact on forage, removal of top predators (potential for seabird bycatch and subsistence harvests of marine mammals), could increase the risk of changes in species, functional, and structural habitat diversity for the ecosystem. Long-term climate changes and regime shifts, in combination with fisheries-related pressures, could adversely affect species diversity due to the natural fluctuations in groundfish stocks. The greater fishing effort under FMP 2.1 could incrementally contribute to energy removal and energy redirection occurring on the groundfish fisheries.

4.6.10 Ecosystem Alternative 2 Analysis

Ecosystems are populations (consisting of single species) and communities (consisting of two or more species) of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure (food web) and material cycles (movement of mass and energy among the groups). The following analyses of potential direct/indirect and cumulative effects of Alternative 2 apply to the BSAI and GOA ecosystems. Where available information allows, each ecosystem is addressed separately.

In most cases, however, information is insufficient to allow individual consideration, and the two ecosystems are treated as a single entity.

As explained in Section 4.5.10, the analyses include numerous indicators representing potential direct, indirect, and cumulative effects of the alternative and specific bookends where applicable. Significance thresholds for the effect categories are presented in Table 4.1-7.

Direct/Indirect Effects FMP 2.1 and FMP2.2 – Ecosystems

Change in Pelagic Forage Availability

Pelagic forage availability is assessed by evaluating population trends in pelagic forage biomass for species with age-structured population models. Trends in bycatch of other forage species (herring, squid, and forage species group) in the groundfish fisheries are a measure of the potential impact on those groups in the BSAI and GOA (Figures H.4-19 and H.4-20 of Appendix H). Table 4.5-81 summarizes the average values from 2003-2008 for these measures and the percent change in the average values from the baseline amounts.

In FMP 2.1, pelagic forage biomass in the BSAI (Bering Sea walleye pollock and Aleutian Islands Atka mackerel) would decline by about 17 percent but would still be high relative to historical levels in the assessment. In the GOA, pelagic forage biomass (specifically, walleye pollock) shows an average increase of about 38 percent from the baseline. Twenty-year biomass projections show similar trends. Bycatch of other forage species almost triples in the BSAI and increases about 45 percent in the GOA. The absolute amount of bycatch in each region is relatively small (4,890 mt and 380 mt, respectively). Estimates of forage biomass from food web models of the EBS indicate that this bycatch is probably a small proportion of the total forage biomass (Aydin *et al.* 2002). However, lack of population-level assessments for some species in the forage species group means that corresponding species-level effects are unknown. If a target fishery were to develop for forage species such as capelin, there is a potential for the combined effects of fishing to affect predators such as seabirds, which leads to a conditionally significant adverse impact of this FMP on seabirds. However, the amount of forage needed by predators is uncertain.

In FMP 2.2, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would decline by about 13 percent. Pelagic forage biomass (specifically, walleye pollock) in the GOA shows an average increase of about 53 percent from the baseline. Twenty-year biomass projections show similar trends. Bycatch of other forage species more than doubles in the BSAI and decreases by about 25 percent in the GOA. The absolute amount of bycatch in each region is relatively small (3,500 mt and 190 mt, respectively). As concluded in FMP 2.1, estimates of forage biomass from food web models of the EBS indicate that this bycatch is probably a small proportion of the total forage biomass (Aydin *et al.* 2002). However, lack of population-level assessments for some species in the forage species group means that corresponding species-level effects are unknown.

Because target species that rely on these forage species for prey are not brought below their MSSTs by these changes, FMP 2.1 and FMP 2.2 are determined to have insignificant effects on the BSAI and GOA target species with respect to pelagic forage availability (Table 4.1-7). The amount of prey needed for Steller sea lions and the importance of adult pollock to northern fur seals have not been determined. The predicted changes in prey for FMP 2.1 and FMP 2.2 may have significantly adverse and conditionally significant adverse effects relative to the baseline for these marine mammals. Sections 4.6.1 through 4.6.8 discuss effects of pelagic forage abundance on other resource categories.

Spatial and Temporal Concentration of Fishery Impact on Forage

Spatial and temporal concentration of fishery impacts on forage species is assessed qualitatively by considering the potential for the alternatives to concentrate fishing on forage species in regions utilized by predators that are tied to land, such as pinnipeds and breeding seabirds. Additionally, possibility for concentration of fishing effort to result in an ESA listing or lack of recovery to an ESA-listed species is considered. FMP 2.1 would continue the existing closures around Steller sea lion rookeries, repeal the ban on forage fish, and open areas previously closed to trawling (except Steller sea lion closures), but still retain the spatial/temporal allocation of TAC for pollock and Atka mackerel. Because this FMP retains Steller sea lion closures, it should not result in space/time concentrations of fisheries removals that would impair the long-term viability of Steller sea lions. If a fishery were to be initiated on the forage species group, there is potential for this to result in removals large enough to impact breeding seabird populations that rely on these smaller forage species. However, the level of removals resulting in significant population-level effects on seabirds is unknown. Bering Sea pollock fisheries have shown increasing catch in northern fur seal foraging habitat, but more research is required to determine if the amounts of pollock removed are having a population-level effect. Therefore, FMP 2.1 is considered to have a conditionally significant adverse effect on the ecosystem with regard to spatial/temporal concentration of fisheries on forage species. FMP 2.2 would continue all the existing closures, including those around Steller sea lion rookeries, and would retain the spatial/temporal allocation of TAC for pollock and Atka mackerel. This FMP is judged to have an insignificant effect on the ecosystem with regard to spatial/temporal concentration of fisheries on forage species.

Removal of Top Predators

Removal of top predators, either through directed fishing or bycatch, is assessed by evaluating the trophic level of the catch relative to trophic level of the groundfish biomass (Figures H.4-21 through H.4-24 of Appendix H), bycatch levels of sensitive top predator species such as birds and sharks (Figures H.4-25 and H.4-26 of Appendix H), and a qualitative evaluation of the potential for catch levels to cause one or more top-level predator species to fall below biologically acceptable limits (minimum stock size threshold for groundfish, lead to ESA listing or prevent recovery of an ESA-listed species). Trophic level of the catch in both the BSAI and GOA is a very stable property, changing less than 3 percent on average from the baseline, and trophic level of the groundfish species for which we have age-structured models, changes less than one percent on average. Under FMP 2.1, top-predator bycatch amounts would increase by an average of about 53 percent relative to the baseline in the BSAI and about 40 percent over the baseline in the GOA. The absolute values of average catch for these species are estimated to be 1,032 mt and 1,840 mt in the respective regions under this FMP (Table 4.5-81). FMP 2.2 would result in top-predator bycatch amounts increasing about 16 percent in the BSAI and decreasing an average of 12 percent in the GOA relative to the baseline. Average catch of these species in the BSAI and GOA is estimated to be 782 mt and 1,150 mt, respectively (Table 4.5-81).

Increased fishing effort and the retention of former seabird protection measures under FMP 2.1 are considered conditionally significant adverse measures for ESA-listed seabirds such as short-tailed albatross. Also, removal of area closures around the Pribilof Islands may lead to disproportionate take of fulmars from that colony. Thus, FMP 2.1 may have a conditionally significant adverse impact on seabird top predators. FMP 2.1 and FMP 2.2would not further impair the recovery of whale species through direct takes. Sections 4.6.7 and 4.6.8 discuss the effects of groundfish fishery direct takes on specific seabird and marine mammal populations. The effect of shark bycatch on shark populations is unknown at present, and research directed at better assessing population levels of these sensitive (late maturing, low fecundity, low natural mortality) species is needed to better assess the potential effects from groundfish fisheries. Section 4.6.3 contains further information on sharks. Stability in trophic level of the catch is indicative of minimal effect of the fishery on target and PWS species top predators (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). See Section 4.6.1 for details on these target species and Section 4.6.2 for Pacific halibut. Overall, FMP 2.1and 2.2 would have insignificant effects on whales, pinnipeds, top-predator target, and PSC species and unknown effects on top predators such as sharks. FMP 2.1 may result in conditionally significant adverse effects on seabirds. However, because seabird bycatch levels in FMP 2.2 are expected to be similar to the baseline, FMP 2.2. is determined to have an insignificant effect on seabird population status.

Introduction of Non-Native Species

The introduction of non-native species through ballast water exchange and hull-fouling organism release from fishing vessels could potentially disrupt Alaskan marine food web structure (Fay 2002). There have been 24 species of non-indigenous species of plants and animals documented primarily in shallow-water marine and estuarine ecosystems of Alaska, with 15 species recorded in PWS. It is possible that most of these introductions were from tankers or other large commercial vessels that have large amounts of ballast exchange. However, exchange via fishery vessels that take on ballast from areas where invasive species have already been established and then transit through Alaskan inshore waters has been identified as a threat in a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). Consequently, this effect is evaluated as conditionally significant adverse in the baseline.

Total groundfish catch levels are used as an indicator of potential changes in the amount of these releases via groundfish fishery vessels (Figures H.4-27 and H.4-28 of Appendix H, Table 4.5-82). Total catch would increase by about 42 percent in the BSAI and 69 percent in the GOA under FMP 2.1, relative to the baseline. These catch levels are at the upper end of catches previously observed in these areas, indicating an increased potential for fishing vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms. Because there is insufficient information regarding fishing effort levels that would result in a successful introduction, this potential effect is evaluated as conditionally significant adverse with respect to predator-prey relationships. Under FMP 2.2, total catch would increase by about 17 percent in the BSAI and 14 percent in the GOA. These catch levels are similar to recent catches in these areas. Therefore, the potential direct/indirect effects of FMP 2.2 on predator-prey relationships through the introduction of non-native species are evaluated as insignificant.

Energy Flow and Balance

As discussed in Section 3.10, fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Baseline energy removals, in the form of total retained catch, were less than one percent of the total system energy determined by mass-balance modeling of the system and were determined to have an insignificant impact on the ecosystem. FMP 2.1 retained-catch removals (Table 4.5-81), which change about 35 percent and 79 percent from the baseline in the BSAI and GOA, respectively, are large changes relative to the baseline. Therefore, potential impacts of FMP 2.1 on energy removals are determined to be conditionally significant adverse with respect to the potential for producing changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7). FMP 2.2

retained-catch removals (Table 4.5-81) change 17 and 20 percent from the baseline in the BSAI and GOA, respectively, and are still less than one percent of the total system energy as determined from mass-balance modeling in the EBS. Impacts of FMP 2.2 on energy removals are determined to be insignificant.

Energy re-direction, in the form of discards or fishery offal production or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the system. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms and make them more vulnerable to predation. Discards and offal production can cause local enrichment and changes in species composition or water quality if discards or offal returns are concentrated there. Estimates of total discards (Table 4.5-81, Figures H.4-29 and H.4-30 of Appendix H) under FMP 2.1 more than doubled for the BSAI and increase approximately 36 percent for the GOA relative to the baseline. Because these amounts are large deviations from baseline conditions, they create potential for a conditionally significant adverse effect on ecosystem-level energy cycling characteristics. Trends in total discards in FMP 2.2 show a more than 16 percent increase in the BSAI and a 4 percent decrease in the GOA. These amounts are still less than one percent of the unused detritus already going to the bottom, as estimated from mass-balance modeling of the EBS. Therefore, FMP 2.2 would have an insignificant effect on ecosystem-level energy cycling characteristics.

Change in Species Diversity

Fishing can alter different measures of diversity. Species-level diversity, or the number of species, can be altered if fishing essentially removes a species from the system. Fishing can alter functional diversity from a trophic standpoint if it selectively removes or depletes a trophic guild member and thus changes the way biomass is distributed within a trophic guild. Functional diversity from a structural habitat standpoint can be altered if fishing methods such as bottom trawling remove or deplete organisms such as corals, sea anemones, or sponges that provide structural habitat for other species. Fishing can alter genetic diversity by selectively removing faster-growing fish or removing spawning aggregations that might have genetic characteristics that are different from other spawning aggregations. Larger, older fishes may be more heterozygous (i.e., have more genetic differences or diversity), and some stock structures may have a genetic component (see review in Jennings and Kaiser 1998). Consequently, one would expect a decline in genetic diversity to result from heavy exploitation of a fishery.

Significance thresholds for effects of fishing on species diversity are catch removals high enough to cause the biomass of one or more species (target or non-target) to fall below, or to be kept from recovering from levels already below MSST for target species, or to result in ESA listing for non-target species (Table 4.1-7). Indicators of significance are population levels of target and non-target species relative to MSST or ESA listing thresholds, linked to fishing removals. Bycatch amounts of sensitive (low population turnover rates) groups that lack population estimates (skates, sharks, grenadiers, and sessile invertebrates, such as corals, inhabiting Habitat Areas of Particular Concern, or HAPC) may also indicate potential for fishing impact on these species (Table 4.5-82, Figures H.4-31 and H.4-32 of Appendix H). Closed areas also provide protection, particularly to less-mobile species like HAPC biota, so the amount of area closures across habitat types can indicate the degree of species-level diversity protection. Baseline determinations were made of insignificance for most of these indicators, and unknown for skates and sharks.

Under FMP 2.1, the only closures would be those required under Steller sea lion protection measures. Bycatch of HAPC biota would increase by about 8 percent in the BSAI and stay about the same in the GOA (Table 4.5-81). However, the bycatch model does not take into account the different bycatch rates that might occur due to opening of previously closed areas, and thus HAPC bycatch amounts could increase by an unknown amount. Furthermore, Steller sea lion closures are closer inshore relative to the distribution of some of the most sensitive HAPC biota, corals, and closures may not provide protection against species-level extinction for this group. FMP 2.1 may have conditionally significant adverse effects on HAPC biota. The increased fishing effort and use of former seabird protection measures in this FMP increase the likelihood for ESA listing or for preventing recovery of ESA-listed seabirds such as the short-tailed albatross. The levels of seabird bycatch that would result from FMP 2.1 are unknown. Increased trawling and potential for trawl third-wire mortality increases relative to the baseline in this FMP and may have a conditionally significant adverse impact to seabird species diversity.

FMP 2.2 results in bycatch of HAPC biota increasing by about 28 percent in the BSAI and decreasing by about 3 percent in the GOA (Table 4.5-81). Area closures would most likely be sufficient to provide protection against species-level extinction for this group of sessile organisms, although more research on coral distributions is needed. Therefore, FMP 2.2 would have an insignificant effect on species diversity with respect to HAPC biota. Catch amounts of target species, prohibited species, seabirds, and marine mammals under this FMP would be insufficient to bring these species below minimum population thresholds and would have an insignificant effect on species diversity for these groups. It is unknown whether bycatch amounts of skates, sharks and grenadiers would be at levels high enough to bring species within these groups to minimum population thresholds. Further research on the species-level distribution, abundance trends, and life-history parameters of these species is necessary to assess potential population-level effects. Although forage species population levels are not known, their relatively high turnover rates would likely protect them from falling below minimum biologically acceptable limits. However, some of the species in this forage group are not well studied (e.g., stichaeids, gunnels), and life-history parameter determination should be a priority for future research. Thus, FMP 2.2 would have insignificant and unknown effects on species diversity.

Catch amounts of prohibited species and marine mammals would be insufficient to bring these species below minimum population thresholds and thus are given an insignificant effect on these groups. Some target species would be depleted to levels below their MSST, a significantly adverse effect on species diversity. It is unknown whether bycatch amounts of skates, sharks, and grenadiers would be at levels high enough to bring species within these groups to minimum population thresholds, but these bycatch amounts would increase in FMP 2.1. Further research on the species-level distribution, abundance trends, and life history parameters of these species is necessary to assess the risk of falling below minimum population abundance thresholds. Although forage species population levels are not known, their relatively high turnover rates would likely protect them from falling below minimum biologically acceptable limits. However, some of the species in this forage group are not well studied (e.g., stichaeids, gunnels). Thus, FMP 2.1 would have insignificant (prohibited species, marine mammals, forage), significantly adverse (some target species), conditionally significant adverse (seabirds, HAPC biota), and unknown (skates, sharks, grenadiers) effects on species diversity. Catch amounts of target species, prohibited species, seabirds, and marine mammals under FMP 2.2 would be insufficient to bring these species below minimum population thresholds and would have an insignificant effect on species diversity for these groups. Potential effects of bycatch on skates, sharks, grenadiers and Other Species are unknown for FMP 2.2. More years of survey data and life-history parameter determination for skates, sharks, grenadiers, and Other Species may better define population trends and help determine whether further protection might be warranted. Sections 4.6.1 through 4.6.8 present detailed analyses of the potential for fishery removals to affect minimum population thresholds for each of these groups and thus ultimately to affect species diversity.

Change in Functional Diversity

Functional (either trophic or structural habitat) diversity can be altered through fishing if fishing selectively removes one member of a functional guild, which may result in increases in other guild members. A functional guild is a group of species that use resources within the ecosystem in similar ways. Significance thresholds are catch removals high enough to cause a change in functional diversity outside the range of natural variability observed for the system (Table 4.1-7). Indicators of the possible magnitude of effects include qualitative evaluation of guild or size diversity changes relative to fishery removals, bottom gear effort changes that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild. In FMP 2.1, it is unknown to what degree changes in trophic guild diversity would result from increasing the catch removals of target species that are guild members. Because walleye pollock and Atka mackerel tend to be dominant members of their respective trophic guilds, fishing removals that cause these species to fall below their MSST would tend to increase trophic guild diversity measures because these species would be less dominant. Consequently, the potential effect of FMP 2.1 on trophic diversity is rated as conditionally significant adverse.

Under FMP 2.1, the possible increases in HAPC biota bycatch that could result from opening areas that were previously closed to bottom trawling have not been modeled. Members of the HAPC biota guild serve important functional roles, known only in a preliminary way, to provide fish and invertebrates with structural habitat and refuge from predation. The abundance of these structural species necessary to provide protection is not known, and it may be important to retain populations of these organisms that are well distributed spatially in order to fulfill their functional role. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Existing Steller sea lion trawl closures are spread throughout the Aleutian chain, which likely has some of the highest densities of coral in the region. However, the closures are in waters shallower than where corals tend to be found. Therefore, the increase in fishing pressure and types of areas closed to trawling in this FMP are not sufficient to provide additional protection beyond the baseline to these sensitive organisms and may result in a potentially adverse population-level change. Consequently, this FMP is evaluated as having a significantly adverse effect on structural habitat diversity.

Under FMP 2.2, the species composition and amounts of removals, bottom gear effort, and bycatch amounts of HAPC biota (Table 4.5-82, Figures H.4-31 and H.4-32 of Appendix H) are similar to baseline conditions, in which fishing impacts on functional guild diversity are determined as insignificant for trophic diversity and for structural habitat diversity. Due to similar trends reflecting baseline conditions, the potential direct/indirect effects of FMP 2.2 on functional diversity, both trophic characteristics and structural habitat, are evaluated as insignificant.

Change in Genetic Diversity

Genetic diversity can be affected by fishing through heavy exploitation of certain spawning aggregations or systematic targeting of older age classes that tend to have greater genetic diversity. Under FMP 2.1, some target species would fall below MSST, but because the spatial/temporal management of TAC in the fisheries would not change, the MSST threshold would not be reached as a result of fishing-related declines in genetic diversity. Thus, an insignificant impact of fishing on genetic diversity is expected for this FMP. However, baseline genetic diversity remains unknown for most species and the actual direct/indirect effects that fishing would have on genetic diversity under this FMP are also largely unknown.

Under FMP 2.2, no target species would fall below MSST, and spatial/temporal management of TAC, catch, and selectivity patterns would remain consistent with present conditions. Consequently, the effect of fishing on genetic diversity would be insignificant under FMP 2.2. However, baseline genetic diversity remains unknown for most species and the actual direct/indirect effects that fishing would have on genetic diversity under this FMP are also largely unknown.

Cumulative Effects FMP 2.1 – Ecosystems

The following sections discuss the potential cumulative effects of FMP 2.1 on the ecosystem, acting additively or interactively with the effects of external human actions and natural processes persisting from the past, existing in the present, and predicted for the reasonably foreseeable future. These potential cumulative effects are summarized in Table 4.5-82. Data and calculations supporting the cumulative energy removal analyses for all of the alternatives are presented in Table 4.5-81.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The direct/indirect effects of implementing FMP 2.1 are expected to be significantly adverse for prey species utilized by the Steller sea lion, and conditionally significant adverse for northern fur seal and seabird prey species. FMP 2.1 would have an insignificant effect on BSAI and GOA groundfish target species with respect to pelagic forage availability. For the Steller sea lion, northern fur seal, and seabirds, the projected fishery-induced changes in pelagic forage biomass may be outside the natural level of abundance or variability for prey species relative to predator demands (Table 4.1-7). However, these predator demands, with respect to both quantity and prey preferences, have not been accurately quantified, and the potential short- and long-term effects of this FMP on top predators cannot be predicted with a high degree of confidence.

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Future climate change, especially a regime shift, would likely affect the productivity, and therefore the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** Direct/indirect effects on pelagic forage availability as modeled under FMP 2.1 are rated as significantly adverse for Steller sea lion prey species and conditionally significant adverse for northern fur seal and seabird prey species. Any potentially adverse contribution by one or more external factors, including State of Alaska directed fishery removals and subsistence harvests of forage fishes such as herring, capelin, or eulachon, would add a small increment of forage fish removal to this significantly or conditionally significant effect without substantially increasing its magnitude. A large marine oil or fuel spill would have the potential to add substantially to the depletion of forage fish populations in combination with heightened fishing pressures under FMP 2.1, resulting in a significantly adverse cumulative effect.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** FMP 2.1 would have a conditionally significant adverse direct/indirect effect on the ecosystem with regard to spatial/temporal concentration of fisheries on forage species. Because this FMP retains Steller sea lion closures, it should not result in space/time concentrations of fisheries removals that would impair the long-term viability of sea lion subpopulations. Levels of forage fish removals sufficient to result in a population-level effect on seabirds are unknown, and there is uncertainty whether a large fishery on forage species would develop under FMP 2.1. Bering Sea pollock fisheries have shown increasing catch in northern fur seal foraging habitat in the baseline, and more research is required to evaluate whether the amounts of pollock removed are having a population-level effect on fur seals. The conditionally significant rating reflects the high degree of uncertainty and lack of data regarding (a) forage requirements of key top predator species and (b) the eventual levels of forage impact that FMP 2.1 fishing effort would produce.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may have persisted into the present and future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such conditions may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery occur mainly inshore, overlap with the groundfish fishery is more likely temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines and adversely impact other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that are synergistic with spatial/temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** Under FMP 2.1, a conditionally significant adverse cumulative effect on pelagic forage availability could result in the reasonably foreseeable future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species and reduce or intensify this potential cumulative effect.

<u>Removal of Top Predators</u>

- **Direct/Indirect Effects.** FMP 2.1 may have conditionally significant adverse effects on seabirds, insignificant effects on whales, pinnipeds, top-predator target species, and PSC species, and unknown effects on sharks. The greatest concern regarding the effects of FMP 2.1 on top predators is the increased potential for bycatch of seabirds. Increased fishing effort and the maintenance of former, rather than improved, seabird protection measures under FMP 2.1 are considered conditionally significant adverse measures for ESA-listed seabirds such as short-tailed albatross. Also, removal of area closures around the Pribilof Islands may lead to disproportionate takes of fulmars from that colony. The conditionally significant rating reflects uncertainty about future bycatch levels and existing population-level effects of bycatch removals on seabird species (Section 3.7).

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific. State of Alaska directed groundfish fisheries, which are small and sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, but past harvests may have had a sustained effect on some populations that persist today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in Federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result from FMP 2.1 in combination with continued high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch will continue in the reasonably foreseeable future. The conditions under which this cumulative effect could be significant are the continuation of high external seabird bycatch rates in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the reasonably foreseeable future, and this could intensify or reduce the potential effects by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** FMP 2.1 could produce a conditionally significant adverse effect on predator-prey relationships through the introduction of non-native species to the BSAI and GOA ecosystems. The condition under which this potential adverse effect would become significant is the establishment of one or more viable exotic populations. This potential effect is rated conditionally significant because there is insufficient information about the relationship between fishing effort levels and the probability that an introduced exotic species would establish a viable population.

- **Persistent Past Effects.** For decades the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002).

From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with FMP 2.1, it is conceivable that viable populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that might allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA.

<u>Energy Removal</u>

- **Direct/Indirect Effects.** The effects of FMP 2.1 on energy removal would be conditionally significant adverse. Because predicted catch levels are large changes relative to the baseline, FMP 2.1 is considered to have the potential for producing changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 2.1 is predicted to have a conditionally significant adverse cumulative effect with respect to energy removal. If the annual total catches of the State of Alaska herring and crab and IPHC halibut fisheries in the reasonably foreseeable future are similar to the 1994-2002 averages, the combined total catch of these external fisheries will represent a 4.3 percent addition to the estimated total catch for the groundfish fisheries alone under this FMP (Table 4.5-81). It is unknown if this additional increment of biomass removal would intensify or make more probable the predicted direct/indirect effect of the groundfish fishery. Further study of fishery removals as energy debits and their resulting ecosystem-level characteristics is needed (Table 4.1-7).

Energy Redirection

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 2.1 on energy redirection are evaluated as conditionally significant adverse. Because total discard biomass projections would result in large changes from baseline conditions under FMP 2.1, the potential for a conditionally significant adverse effect on ecosystem-level energy cycling characteristics exists (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 2.1 is predicted to have a conditionally significant adverse effect on the ecosystem through energy redirection. The large increase in fishing effort that would occur under this FMP, in combination with external sources such as the IPHC halibut fishery, State of Alaska commercial fisheries, annual subsistence harvests of fish and marine mammals, and the release of graywater and refuse from commercial shipping, could create the potential for a cumulative effect that results in long-term changes outside the range of natural variability. At the local level, water quality degradation can be expected from the increased release of fish processing offal into low-energy environments, such as coves and bays, where nutrients from these wastes can concentrate in sheltered waters and alter local patterns of energy cycling. Although this is not an ecosystem-level effect, it is noted as a consequence of commercial fishing that will continue into the future and may increase under FMP 2.1. The discharge of offal from fish processing facilities and graywater and other refuse from marine vessels into Alaskan waters is regulated through EPA and ADEC permitting programs.

Change in Species Diversity

- **Direct/Indirect Effects.** Predicted effects of FMP 2.1 on species diversity are rated as significantly adverse for target species that would be reduced to levels below their MSSTs, conditionally significant adverse for HAPC biota because of uncertainty regarding the extent to which bycatch of these organisms would increase, conditionally significant adverse for seabirds because of increased fishing effort without a compensatory increase in seabird protection measures, insignificant for prohibited species, forage fish, and marine mammals, and unknown for skates, sharks, grenadiers, and Other Species.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, beluga whales, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 2.1 , a significantly adverse effect on species diversity could result from seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may establish a viable population that would change species diversity in a adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species. Under some combination of these conditions, the biomass of one or more species could fall below minimum biologically acceptable limits (Table 4.1-7).

<u>Change in Functional (Trophic) Diversity</u>

- **Direct/Indirect Effects.** Potential effects on functional diversity in terms of trophic (nutrition-related) characteristics relate to changes in the variety of species within trophic guilds. Under FMP 2.1, the predicted effects of the groundfish fisheries on trophic diversity are rated as conditionally significant adverse. This rating reflects the potential for increased fishing effort to cause pollock and Atka mackerel to fall below their MSSTs, thereby making them less dominant members of their guild. Due to the inability to predict the level of diversity change that may result, this rating is conditional based on the ability of the effect to cause changes in functional diversity outside the range of natural variability observed for the system (Table 4.1-7).

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 2.1 could produce a conditionally significant adverse effect on trophic diversity. If the farming of Atlantic salmon along the Pacific coast continues or increases, there is a potential for escaped or released fish to establish one or more viable populations in the future, thus adding a new salmonid to the trophic structure. Other exotic species introduced through commercial shipping and fishing vessels also have the potential to establish viable populations, especially if facilitated by a favorable climatic change, thus altering trophic diversity. In addition, subsistence mammal harvests, particularly where individual subpopulations are placed under pressure, have the potential to affect species diversity within piscivore guilds, at least locally. None of these potential external effects is likely to be interactive or synergistic with the direct/indirect effects of FMP 2.1, because different trophic guilds would be affected, but an additive effect is possible.

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to functional diversity in terms of structural habitat is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures for habitat by other species, including economically important groundfish species and their prey. Present (comparative baseline) trawl closures to protect the Steller's sea lion are spread throughout the Aleutian chain, but these closures are in waters shallower than where corals tend to be found. Because the areas that would be closed to trawling under FMP 2.1 would be similar to the comparative baseline conditions, they would not be sufficient to provide protection to these sensitive organisms. Therefore, the potential direct/indirect effects of FMP 2.1 on functional diversity are rated as significantly adverse.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** The implementation of FMP 2.1 may produce a significantly adverse cumulative effect on structural habitat diversity by damaging or removing benthic HAPC biota, particularly coral. Direct/indirect effects of FMP 2.1 could be intensified under at least three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could add to the effects of bottom trawling by the groundfish fisheries on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity (and thus population size, growth, and ability to recover from damage) as well as distribution of sensitive bottom-dwelling invertebrates that provide ecologically important structural habitat.

<u>Change in Genetic Diversity</u>

- **Direct/Indirect Effects.** If FMP 2.1 were implemented, no target species would fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to present conditions. Fishing pressure would not focus on specific spawning aggregations or systematically target older age classes that tend to have greater genetic diversity. Therefore, effects of the groundfish fisheries on genetic diversity are expected to be insignificant under FMP 2.1. However, baseline genetic diversity remains unknown for most species and the actual effects that fishing would have on genetic diversity under this FMP are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, beluga whales, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 2.1 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. However, none of these factors would directly involve the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. For this reason, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

Cumulative Effects FMP 2.2 – Ecosystems

The following sections discuss the potential cumulative effects on the ecosystem of FMP 2.2, acting additively or interactively with the effects of external human actions and natural processes persisting from the past, occurring in the present, and predicted for the future. These potential cumulative effects are summarized in Table 4.5-82. Data and calculations supporting the cumulative energy removal analyses for all of the alternatives are presented in Table 4.5-81.

<u>Change in Pelagic Forage Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.2, BSAI pelagic forage biomass, as estimated by Bering Sea pollock and Aleutian Islands Atka mackerel, is predicted to decrease relative to the comparative baseline. Total biomass of GOA pollock is predicted to increase during the same period (Table 4.5-81). Bycatch of other forage species would increase by more than 200 percent in the BSAI and decrease by about 25 percent in the GOA. Because target species that rely on these forage species for prey would not be brought below their MSSTs by these changes, FMP 2.2 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability (Table 4.1-7). However, the quantities of prey needed by Steller sea lions and the importance of adult pollock to northern fur seals have not been determined. Consequently, the predicted changes in pelagic forage availability may have significantly adverse and conditionally significant adverse effects relative to the baseline for these marine mammals.

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** Direct/indirect effects on pelagic forage availability as modeled under FMP 2.2 are rated as significantly adverse for Steller sea lion prey species and conditionally significant adverse for northern fur seal. Any potentially adverse contribution by one or more external factors, including State of Alaska directed fishery removals and subsistence harvests of forage fishes such as herring, capelin, or eulachon, would add a small increment of forage fish removal to this significantly or conditionally significant effect without substantially increasing its magnitude. However, a large marine oil or fuel spill could have the potential to add substantially to the depletion of forage fish populations, resulting in a significantly adverse cumulative effect for the Steller sea lion and northern fur seal.

<u>Spatial/Temporal Concentration of Fishery Impact on Forage</u>

- **Direct/Indirect Effects.** FMP 2.2 would have an insignificant effect on the ecosystem with regard to spatial/temporal concentration of fisheries on forage species. It would not result in fishing concentrations on forage species high enough to impair the long-term viability of the Steller sea lion and other marine mammals or seabirds (Table 4.1-7).

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may persist (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such conditions may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery occurs mainly inshore, overlap with the groundfish fishery will be temporal more than spatial.

Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS in 1989 suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning will most likely produce population declines, and adverse impacts to other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that might be synergistic with spatial/temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** Under FMP 2.2, a conditionally significant adverse cumulative effect on pelagic forage availability could result in the future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring, and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (see Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species by reducing or intensifying this potential cumulative effect.

Removal of Top Predators

- **Direct/Indirect Effects.** FMP 2.2 would have insignificant effects on whales, pinnipeds, seabirds, top-predator target species, and PSC species in their function as top predators; and unknown effects on sharks as top predators. Trophic level of the catch, affecting top predators that are target species, would not change significantly from the baseline and would not result in any species near or below MSST. Top predator bycatch amounts would increase over the baseline in the BSAI and decrease in the GOA; these changes would not cause the biomass of one or more top predator species to fall below minimum biologically acceptable limits (Table 4.1-7).

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling resulting in very high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific (Section 4.5.11). State of Alaska directed groundfish fisheries, which are sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have sustained effects on some populations today (Section 3.10.1). Finally, there is evidence that past climatic variability may affect the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in Federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result from FMP 2.2 in combination with continued high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch will continue in the reasonably foreseeable future. The conditions under which this cumulative effect could be significant are the continuation of high external seabird bycatch rates, intensified by contributions from a large fuel or oil spill and incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and could intensify or reduce the potential cumulative effect by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** The potential effects of FMP 2.2 on predator-prey relationships through the introduction of non-native species would be insignificant. The estimated catch levels are similar to recent catches in these areas, indicating a similar level of effort and thus a similar potential for fishing vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms.

- **Persistent Past Effects.** For decades the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When considering sources of exotic species external to the domestic groundfish industry in combination with FMP 2.2, it is conceivable that viable populations could become established in the BSAI and/or GOA in the future, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that may enable exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA.

Energy Removal

- **Direct/Indirect Effects.** The effects of FMP 2.2 on energy removal are expected to be insignificant. Baseline energy removals, in the form of total catch, are less than one percent of the total ecosystem energy, as estimated by mass-balance modeling, and were determined to have an insignificant impact on the ecosystem. Total retained catch removals under FMP 2.2 would increase but are less than one percent of the total system energy as estimated from mass-balance modeling for the EBS. These estimated energy removals would not have the potential to produce significant changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 2.2 would have an insignificant cumulative effect on energy removal in the future. The total domestic groundfish catch under this FMP is estimated to remove less than one percent of the total system energy. If the combined total catch of the State of Alaska herring and crab and IPHC halibut fisheries in the future is similar to the 1994-2002 average, the cumulative total catch of these external fisheries plus the BSAI and GOA groundfish fisheries will increase by about 5.3 percent over the estimated total catch for this FMP alone (Table 4.5-81). This additional increment of biomass removal is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability due to expected energy removals by the BSAI and GOA groundfish fisheries (Table 4.1-7).

<u>Energy Redirection</u>

- **Direct/Indirect Effects.** The effects of FMP 2.2 on energy redirection are expected to be insignificant. Projections for total discards are less than one percent of the estimate of unused detritus already going to the bottom under the baseline conditions, as determined from mass-balance modeling of the EBS. They would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and from subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. The pattern of such disposal at sea is not expected to change much in the future. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 2.2 is predicted to have an insignificant cumulative effect on energy redirection. The cumulative effect of FMP 2.2 in combination with external sources is not expected to depart significantly from the comparative baseline condition as to produce long-term changes outside the range of natural variability. At the local level, water quality degradation can be expected from the release of fish processing offal into low-energy environments, such as coves and bays, where nutrients from these wastes can concentrate in sheltered waters and alter local patterns of energy cycling. Although this is not an ecosystem-level effect, it is noted as a consequence of commercial fishing that will continue into the future and that may increase under FMP 2.2. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through EPA and ADEC permitting programs.

<u>Change in Species Diversity</u>

- **Direct/Indirect Effects.** Predicted effects of FMP 2.2 on species diversity are rated as insignificant with respect to all groups except skates, sharks, and grenadiers, for which the potential effects on species diversity are unknown because of the paucity of information on these groups. Under FMP 2.2, bycatch of HAPC biota would increase by about 28 percent in the BSAI and decrease by about 3 percent in the GOA (Table 4.5-81). Area closures would most likely be sufficient to provide protection against species-level extinction for this group of sessile organisms, although more research on coral distributions is needed. Catch amounts of target species, prohibited species, seabirds, and marine mammals under FMP 2.2 would be insufficient to bring these species below minimum population thresholds. Although forage species population levels are not known, their relatively high turnover rates would most likely protect most of them from falling below minimum biologically acceptable limits.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, beluga whales, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 2.2 , a conditionally significant adverse cumulative effect on species diversity could result from a high level of seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may establish a viable population that would change species diversity in a adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible sub-populations of marine mammals from year to year could intensify this effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species.

<u>Change in Functional (Trophic) Diversity</u>

- **Direct/Indirect Effects.** Potential effects on trophic diversity relate to changes in the variety of species within trophic guilds. The greater the diversity of species within guilds, the more resilient the ecosystem is likely to be, because competing species within the same guild can replace or substitute for one another in response to environmental stressors, thereby maintaining the structure of the food web. Under FMP 2.2, the predicted effects of the groundfish fisheries on trophic diversity are rated as insignificant. This reflects the similarity of the expected species composition and amounts of removals, bottom gear effort, and bycatch amounts of HAPC biota under this FMP (Table 4.5-82, Figures H.4-31 and H.4-32 of Appendix H) to the baseline, for which fishing impacts on trophic diversity were determined to be insignificant.

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 2.2 could produce a conditionally significant adverse effect on trophic diversity. The condition under which this potential effect could be significant relates to the additive effect of incremental contributions from several possible sources. If the farming of Atlantic salmon along the Pacific coast continues or increases, there is a potential for escaped or released fish to establish one or more viable populations in the reasonably foreseeable future, thus adding a new salmonid to the trophic structure. Other exotic species introduced through commercial shipping and fishing vessels also have the potential to establish viable populations, especially if facilitated by a favorable long-term climatic change, and thus alter trophic diversity. In addition, subsistence mammal harvests, particularly where individual subpopulations are placed consistently under pressure from year to year, have the potential to affect species diversity within piscivore guilds, at least locally. None of these potential external effects is likely to be interactive or synergistic with the direct/indirect effects of FMP 2.2, because different trophic guilds would be affected, but an additive effect is possible.

<u>Change in Functional (Structural Habitat) Diversity</u>

- **Direct/Indirect Effects.** The issue of concern with respect to structural habitat diversity is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures used as habitat by other species, including economically important groundfish species and their prey. It is important to ensure that the spatial distribution of areas closed to bottom fishing is broad enough, relative to coral distribution in particular, to allow these organisms to fulfill their functional role. Present (comparative baseline) trawl closures to protect the Steller's sea lion are spread throughout the Aleutian chain, but these closures may be farther inshore than most of the coral. Because the areas that would be closed to trawling under FMP 2.2 would show little change from the comparative baseline conditions, the potential direct/indirect effects of FMP 2.2 are rated as insignificant.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** The implementation of FMP 2.2 may produce a conditionally significant adverse effect on structural habitat diversity by adversely affecting benthic HAPC biota. Effects of FMP 2.2, rated insignificant because they would show little change from existing circumstances, could be intensified under at least three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could add to the effects of bottom trawling by the groundfish fisheries on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity, and thus the population size, as well as the distribution, of bottom-dwelling invertebrates that provide structural habitat.

<u>Change in Genetic Diversity</u>

- **Direct/Indirect Effects.** If FMP 2.2 were implemented, no target species would fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to present conditions. Fishing pressure would not focus on specific spawning aggregations or systematically target older age classes that tend to have greater genetic diversity. Consequently, the effect of the groundfish fisheries on genetic diversity are expected to be insignificant under FMP 2.2. However, a baseline condition for genetic diversity remains unknown for most species and the actual effects that fishing could exert on genetic diversity under this FMP are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, beluga whales, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 2.2 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would directly involve the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. For this reason, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

4.6.11 Summary of Alternative 2 Analysis

The direct, indirect and cumulative ratings for all resource categories analyzed under this alternative are summarized in Tables 4.6-1 through 4.6-7.

Table number	Resource category	Components	Section 4.6 reference
4.6-1	Target groundfish species	Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) walleye pollock, BSAI and GOA Pacific cod, BSAI and GOA sablefish, BSAI and GOA Atka mackerel, BSAI yellowfin sole, GOA shallow water flatfish, BSAI rock sole, BSAI and GOA flathead sole, BSAI and GOA arrowtooth flounder, BSAI Greenland turbot, GOA deepwater flatfish, BSAI Alaska plaice, BSAI other flatfish, GOA rex sole, BSAI and GOA Pacific ocean perch, GOA thornyhead rockfish, BSAI and GOA northern rockfish, BSAI and GOA shortraker/rougheye rockfish, BSAI other rockfish, GOA slope rockfish, GOA pelagic shelf rockfish, GOA demersal shelf rockfish.	4.6.1
4.6-2	Prohibited, other, forage and non-specified species	Pacific halibut, Pacific salmon and steelhead trout, Pacific herring, crab. Other species category. Forage fish category. Grenadier.	4.6.2 4.6.3 4.6.4 4.6.5
4.6-3	Habitat	BSAI, GOA	4.6.6
4.6-4	Seabirds	Black-footed albatross, laysan albatross, short-tailed albatross, northern fulmar, shearwaters, storm-petrels, cormorants, spectacled eider, Seller's eider, jaegers, gulls, kittiwakes, terns, murres, guillemots, murrelets, auklets, puffins.	4.6.7
4.6-5	Marine mammals	Steller sea lion, northern fur seals, Pacific walrus, harbor seals, spotted seal, bearded seal, ringed seal, ribbon seal, northern elephant, sea otter, blue whale, fin whale, sei whale, minke whale, humpback whale, gray whale, northern right whale, bowhead whale, sperm whale, beaked whales (Baird's, Cuvier's and Stejneger's), Pacific white-sided dolphin, killer whale, beluga whale, harbor porpoise, Dall's porpoise.	4.6.8
4.6-6	Socioeconomics	Harvesting and processing sector (catcher vessels, catcher processors, inshore processors and motherships). Regional socioeconomic profiles (population, processing ownership and activity, catcher vessel ownership and activity, tax revenue, employment and income). Community development quota (CDQ) allocations. Subsistence (subsistence use of groundfish, subsistence use of Steller sea lions, salmon subsistence fisheries, indirect subsistence factors: income and joint production). Environmental justice. Market channels and benefits to United States consumers (product quantity, product year-round availability, product quality, product diversity). Non-market goods (benefits derived from marine ecosystems and associated species).	4.6.9.1 4.6.9.2 4.6.9.3 4.6.9.4 4.6.9.5 4.6.9.6 4.6.9.7
4.6-7	Ecosystem	Forage fish availability, spatial/temporal concentration of fisheries, introduction of non-native species, removal of top predators, energy redirection, energy removal, species diversity, guild diversity, genetic diversity.	4.6.10