4.5 Alternative 1 Analysis

FMP 1 models status quo management, which has the goal of maintaining sustainable fisheries, protecting threatened and endangered species, and protecting, conserving, and restoring living marine resource habitats through existing institutions and processes. This alternative is described in detail in Section 2.6.

4.5.1 Target Groundfish Species Analysis

This section examines the potential direct, indirect, and cumulative effects that the implementation of FMP 1 is expected to have on the target groundfish species. 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 FMP 1. These projections from the model are the predicted direct and indirect effects (impacts) of FMP 1 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.

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

Direct/Indirect Effects

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

Change in Biomass Level: 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.

Spatial/Temporal Concentration of Catch: 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.

Habitat Suitability: 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 (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 FMP 1 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.5-83. 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.

4.5.1.1 Pollock

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 1

The following discussions describe the analysis of potential direct and indirect impacts of FMP 1 on EBS and GOA pollock. As summarized in Table 4.5-83, all direct and indirect effects of FMP 1 on pollock are expected to be insignificant, as defined by the criteria in Table 4.1-1.

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 30 percent and average 0.228 for the period 2003-2007 (Table H.4-1 of Appendix H). 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 51 percent in 2003, decreasing to 48 percent by 2007; the average implied SPR rate of fishing from 2003-2007 is 49 percent. Fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under FMP 1 (Table H.4-2 of Appendix H). Because the projected changes are not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis, the effects of FMP 1 on fishing mortality for the EBS pollock stock are considered to be insignificant.

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.139 in 2003 followed by increases to 0.209 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 56 percent for the period 2003-2007. This F pattern is due to the fact that under this FMP, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$. Model projections for GOA fishing mortality are shown in Table H.4-23 of Appendix H. Because they are not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis, these changes in fishing mortality levels for GOA pollock are considered to be insignificant.

Change in Biomass Level

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 1, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.3 million mt in 2004, then stabilize to about 11.6 million mt. The 2003-2007 average total biomass is projected to be 11.5 million mt. The direct effects of FMP 1 are considered insignificant, because the biomass levels estimated for 2003-2007 are expected to be above the biomass proxy value necessary to sustain maximum sustainable yield (B_{MSY}) and thus maintain the ability of the EBS stock to sustain itself above the MSST.

In the Aleutian Islands region, the assessments are based on trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Given that under FMP 1 there is no directed fishing for pollock in this region (the exploitation level is quite low, less than 1 percent), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island pollock stock. For this reason, the direct effect of FMP 1 on the total biomass of the Aleutian Islands and Bogoslof Island pollock stocks is expected to be insignificant.

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,210,000 mt by 2007. The average biomass over this period is expected to be 1,030,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels. Model projections of future total GOA pollock biomass are shown in Table H.4-23 of Appendix H. The predicted direct effects of FMP 1 on GOA total pollock biomass are considered insignificant, because the biomass levels estimated for 2003-2007 are expected to maintain the ability of the GOA stock to sustain itself above the MSST.

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. Under FMP 1, projections indicate that EBS pollock spawning biomass will decrease to about 81 percent of the 2002 level by 2007. The projected average for 2003-2007 is 3.08 million mt. Because this level of decrease in female spawning biomass would not prevent the EBS pollock stock from sustaining itself at or above the MSST, the direct effect of FMP 1 on EBS pollock spawning biomass is considered to be insignificant.

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 1 these areas are kept at bycatch-only levels, we expect the spawning stock size to remain stable or increase in these regions. For this reason, the direct effect of FMP 1 on the spawning biomass of these stocks is expected to be insignificant.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 228,000 mt by 2007 under FMP 1. This is above the estimated B_{MSY} level of 210,000 mt although the average from 2003-2007 is 183,000 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H. Because the estimated increase in female spawning biomass is expected to maintain the ability of the GOA pollock stock to sustain itself above the MSST, this effect is considered to be insignificant.

Spatial/Temporal Concentration of Catch

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 (January 20-March). Under FMP 1, an average of 1.4 million mt of EBS pollock is projected to be harvested annually from 2003-2007. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period. Because the spatial/temporal concentration of the catch under FMP 1 would not change notably from existing conditions, there is no evidence to suggest that harvest concentrations would be sufficient to alter genetic sub-populations or reproductive success in ways that affect the ability of the EBS pollock stock to sustain itself at or above the MSST. Therefore, this potential effect is considered to be insignificant.

Under FMP 1, an average of 87,300 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 133,000 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery may change from the 2002 pattern. However, there is no indication that under FMP 1, harvest concentrations would change sufficiently to alter genetic sub-populations or reproductive success in ways that affect the ability of the GOA pollock stock to sustain itself at or above the MSST. Therefore, the direct effect of FMP 1 on the spatial and temporal concentration of the catch is expected to be insignificant relative to baseline conditions.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Given the similarity of FMP 1 to the status quo, however, it is unlikely that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success sufficient to jeopardize the ability of the stocks to sustain themselves at or above the MSST. Therefore, the direct and indirect effects of FMP 1 on EBS and GOA pollock habitat suitability are expected to be insignificant.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 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. Because of its similarity to the status quo, however, it is unlikely that FMP 1 would introduce changes in predator-prey interactions sufficient to affect the ability of pollock stocks to maintain themselves at or above the MSST. Therefore, the direct and indirect effects of FMP 1 on EBS and GOA pollock prey availability are expected to be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on Pollock

The impact assessments discussed above indicate that the direct and indirect effects of FMP 1 on BSAI and GOA pollock would be insignificant for all of the effects categories (see Appendix A, Table 4.5-83). In addition, the fact that pollock would be fished at less than the OFL and above the MSST provides a separate rationale for considering the direct and indirect effects under FMP 1 to be insignificant. Fishing rates under this FMP would be well within accepted scientific standards, based on studies of population dynamics and estimates of natural variations in recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity. Based on extended 20-year projections (with the same model assumptions as used in the base 2003-2007 period), both the EBS and GOA pollock are expected to stabilize with catches lower than the expected long-term F_{ABC} catch levels and Bs above the B_{MSY} levels.

Status Determination from Modeling

Modeling projections for 2003-2007 indicate that under FMP 1, the future status of EBS and GOA pollock stocks would be as follows for key indicators.

Stock Size Relative to MSST

Under FMP 1, 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 1, 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 1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.53 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.00 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). Model projections of EBS and GOA pollock age and size compositions are shown in Tables H.4-1 and H.4-23 of Appendix H.

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock are 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 would be affected under FMP 1.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are shown in Tables 4.5-1 and 4.5-2. For further information regarding persistent past effects listed below in the text and in the tables, see Sections 3.5.1.1 and 3.5.1.15.

EBS Pollock

Mortality

- **Direct/Indirect Effects**. As described above under direct/indirect effects, the effect of fishing mortality on the EBS pollock stock is insignificant under FMP 1.

- **Persistent Past Effects.** The past effects of the foreign, Joint Venture (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 U.S. 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 contributing factors since catch is accounted for. Marine pollution is also 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.** The cumulative effects under FMP 1 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 threshold (MSST). 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.** As described above in Section 4.5.1.1, change in biomass of the EBS pollock stock is expected to be insignificant under FMP 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, the effects of any future removals are expected to be negligible and 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, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect on the change in biomass is identified; however, 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.

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

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

- **Direct/Indirect Effects.** Under FMP 1, the harvest of EBS pollock will continue to occur mostly along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W longitude during the period (January 20 - March). Under these considerations, the spatial/temporal distribution of catch 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 3.5.1.1) 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 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. On the other hand, removals in these fisheries could have a potential beneficial effect 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; 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 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see above discussion of direct/indirect effects). However, it is determined that FMP 1 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.** Past effects of climate changes and regime shifts on pollock prey species could have potential beneficial or potential adverse effects. 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 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 effect is 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 1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see above discussion of direct/indirect effects). However, it is determined that FMP 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 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external 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 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, that 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 1 (see Section 4.5.1.1 Direct/Indirect Effects discussion).

- **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 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Catch and bycatch of pollock in the State of Alaska pollock fisheries, and State of Alaska shrimp fisheries, climate changes, and regime shifts 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. However, marine pollution could have 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.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of GOA 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 GOA pollock stock is expected to be insignificant under FMP 1 (see Section 4.5.1.1).

- **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 State of Alaska pollock fisheries. However, these 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.** A cumulative effect for change in biomass is identified; 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.

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

- **Direct/Indirect Effects.** Under FMP 1 in the GOA, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.5.1.1 Direct/Indirect Effects discussion).

- **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, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** While there are potential adverse effects due to the State of Alaska pollock fisheries, and the State of Alaska shrimp fishery these fisheries are not 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 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 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see Section 4.5.1.1 Direct/Indirect Effects discussion). However, it is determined that FMP 1 would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** Lingering population level effects are not expected on these species from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, the effects of the *Exxon Valdez* Oil Spill (EVOS). However, 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.** As described for BSAI pollock, climate changes and regime shifts could have beneficial or adverse effects depending on water temperature changes. Marine pollution is a potential 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 4.5-2 are determined have potential adverse effects due to the removal of prey species as catch and bycatch. However, they are not likely to have population level effects on pollock.

- **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.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 1 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, State of Alaska, and domestic fisheries, EVOS, 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 GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **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 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.** Cumulative effects are identified for habitat suitability; however, that 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.

4.5.1.2 Pacific Cod

Numerous fishery management actions have been implemented that affect the Pacific cod fisheries in the BSAI and GOA. These actions are described in more detail in Sections 3.5.1.2 and 3.5.1.16 of this Programmatic SEIS. Pacific cod is managed as separate stocks in the BSAI and GOA, both of which are managed under Tier 3a.

Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI and GOA Pacific cod. All direct and indirect effects of FMP 1 on Pacific cod are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The F imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI Fs are shown in Table H.4-3 of Appendix H. Under FMP 1, model projections indicate that BSAI fishing mortality will increase to a value of 0.286 in 2003, decrease to a value of 0.269 in 2005, increase to a value of 0.274 in 2006,and then decrease to a value of 0.267 in 2007, with a 2003-2007 average of 0.275. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the overfishing level for stocks above $B_{40\%}$. The projected changes in the F are considered to be insignificant, because they would not jeopardize the capacity of the stock to produce MSY on a continuing basis.

The F imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA Fs are shown in Table H.4-24 of Appendix H. Under FMP 1, model projections indicate that GOA fishing mortality is expected to decrease steadily to a value of 0.204 in 2007, with a 2003-2007 average of 0.211. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the overfishing level for stocks above $B_{40\%}$. These projected changes in the F are also considered to be insignificant, because they would not jeopardize the capacity of the GOA stock to produce MSY on a continuing basis.

Change in Biomass Level

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 of Appendix H. Under FMP 1, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,118,000 mt in 2007, with a 2003-2007 average value of 2,086,000 mt. This projected increase is considered to be insignificant, because it would tend toward a level that would maintain the existing ability of the stock to sustain itself above the MSST.

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 1, model projections indicate that total GOA biomass is expected to increase steadily to a value of 713,000 mt in 2007, with a 2003-2007 average value of 645,000 mt. This projected increase is considered to be insignificant, because it would tend toward a level that would maintain the existing ability of the stock to sustain itself above the MSST.

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. Under FMP 1, 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 445,000 mt in 2006, then decrease to a value of 443,000 mt in 2007, with a 2003-2007 average value of 430,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007. The projected fluctuations in B are considered to be insignificant, because they would tend toward levels that would maintain the existing ability of the stock to sustain itself above the MSST.

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. Under FMP 1, model projections indicate that GOA spawning biomass is expected to decrease to a value of 86,400 mt in 2004, then increase to a value of 98,800 mt in 2007, with a 2003-2007 average value of 91,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007. The projected fluctuations in B are considered to be insignificant, because they would tend toward levels that would maintain the existing ability of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

Under FMP 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 problematic 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 undertake large migrations, and a high degree of genetic mixing appears to exist. In comparison to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort on Pacific cod are probably diluted to some extent, and also that their evaluation involves a larger number of difficult-to-estimate parameters. However, there is no indication that under FMP 1, harvest concentrations would change sufficiently to alter genetic sub-populations or reproductive success in ways that affect the ability of the GOA pollock stock to sustain itself at or above the MSST. Therefore, the direct effect of FMP 1 on the spatial and temporal concentration of the catch is expected to be insignificant relative to baseline conditions.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Because fishing practices under FMP 1 would be similar to the status quo, however, it is unlikely that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success sufficient to jeopardize the ability of the stock to sustain itself at or above the

MSST. Therefore, the direct and indirect effects of FMP 1 on Pacific cod habitat suitability are expected to be insignificant.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Because of its similarity to the status quo, however, it seems unlikely that FMP 1 would introduce changes in predator-prey interactions sufficient to affect the ability of the Pacific cod stock to maintain itself at or above the MSST. Therefore, the direct and indirect effects of FMP 1 on prey availability for Pacific cod are expected to be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on Pacific Cod

The criteria used to rate the significance of impacts of FMP 1 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks and are described in Appendix A, Table 4.1-1. Appendix A, Table 4.5-83 summarizes the expected effects of FMP 1 on Pacific cod. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects in this analysis, because the analytic model yields projections that can be classified only as significant (beneficial or adverse), insignificant, or unknown.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 1 on fishing mortality and biomass is rated as insignificant, because the projection model indicates that fishing mortality would be less than the overfishing level and that 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 affect 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 1 are expected to be no greater than those of the existing concentration, the magnitude of this effect is rated as insignificant for both stocks.

Similarly, 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 affect 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 1 are expected to be no greater than those of the existing concentration, the magnitude of this effect is rated as insignificant for both stocks.

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 affect either stock's ability to maintain itself at or above the MSST, and because the level of groundfish harvest under FMP 1 is expected to be no greater than the existing level, the magnitude of this effect is rated as insignificant for both stocks.

Finally, 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 affect either stock's ability to maintain itself at or above the MSST, and because the level of habitat disturbance under FMP 1 is expected to be no greater than the existing level, the magnitude of this effect is rated as insignificant for both stocks.

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: neither stock is overfished, the biomass of each stock 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 1, both stocks are projected to remain above MSST throughout the period 2003-2007; the biomass of the BSAI stock is projected to be above $B_{40\%}$ throughout the period 2003-2007 while the biomass of the GOA stock is projected to be below $B_{40\%}$ in 2003-2005, the biomass of each stock is expected to show an overall increase during the period 2003-2007 and beyond, and all catch and bycatch would continue to be accounted for in the management of both stocks.

Status Determination from Modeling

Modeling projections for 2003-2007 suggest that under FMP 1, the future status of the BSAI and GOA Pacific cod stocks would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI and GOA Pacific cod are below their respective overfishing levels in all years under FMP 1 (Tables H.4-3 and H.4-24 of Appendix H). 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 1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 1, 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 1.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are depicted on Tables 4.5-3 and 4.5-4. For further information regarding persistent past effects listed below in the text and in the tables, see the past/present effects analysis section of Sections 3.5.1.2 and 3.5.1.16.

BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and Pacific cod stock is insignificant under FMP 1 (see the direct/indirect discussion 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 above).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the International Pacific Halibut Commission (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 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 1 is identified for mortality of BSAI Pacific cod, but 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.** As described in Section 4.5.1.2 direct/indirect effects, change in biomass of the BSAI Pacific cod stock is expected to be insignificant under FMP 1.

- **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.** 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. However, these 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 Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, 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.

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

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

- **Direct/Indirect Effects.** Under FMP 1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population. Pacific cod are migratory species and a large degree of genetic mixing appears to exist. This likely means that the spatial/temporal concentration of fishing effort is diluted to some extent.

- **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.** 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 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 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 1 would have insignificant effects on Pacific cod prey availability (see the direct/indirect effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state 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 are unknown; however, 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 shown in 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 effects are 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 1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see above). Because the level of habitat disturbance under FMP 1 is expected to be no greater than the existing level, the effect is rated as insignificant.

- **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 fishery, and climate changes and regime shifts (see Section 3.5.1.2). Previous Pacific cod fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **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, 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.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under FMP 1 (see direct/indirect effects discussion above).

- **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 persistent past effects above).

- **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 1 is identified for mortality of GOA Pacific cod, but 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 1 (see Section 4.5.1.2 direct/indirect effects discussion).

- **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.** 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 in the State of Alaska groundfish fisheries. However, these 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 Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, 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 1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population. Pacific cod are migratory species and a large degree of genetic mixing appears to exist. This likely means that the spatial/temporal concentration of fishing effort is diluted to some extent.

- **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 particularly in the GOA where the state 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 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, subsistence use, and State of Alaska groundfish fisheries 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 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 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that FMP 1 would have insignificant effects on Pacific cod prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state 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 are unknown; however, 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 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; 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.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see Section 4.5.1.2 direct/indirect effects discussion above). Because the level of habitat disturbance under FMP 1 is expected to be no greater than the existing level, the effect is rated as insignificant.

- **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 fishery, and climate changes and regime shifts (see Section 3.5.1.2). 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 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **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 GOA 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, the combination of internal and external impacts on habitat is not expected to jeopardize the ability of the Pacific cod stock to sustain itself at or above MSST.

4.5.1.3 Sablefish

This section provides the direct, indirect, and cumulative effects analyses for sablefish under FMP 1. 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 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on sablefish. All direct and indirect effects of FMP 1 on sablefish are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1. Sections 3.5.1.3 and 3.5.1.17 provide additional information on the past/present effects analysis for BSAI and GOA sablefish.

Fishing Mortality

Under FMP 1, 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. Model projections of future BSAI and GOA fishing mortalities are shown in Tables H.4-11 and H.4-30 of Appendix H. The projected changes in the F are considered to be insignificant, because they would not jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

FMP 1 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. FMP 1 assumptions are intended to replicate baseline conditions, in which biomass tends toward levels that maintain the ability of the BSAI and GOA sablefish stocks to sustain themselves above the MSST. Total biomass increases from 2002-2007 under FMP 1 because long-term average recruitment (1977-present) is used to project biomass and is higher than most of the recent recruitments. Model projections of future BSAI and GOA total biomasses are shown in Tables H.4-11 and H.4-30 of Appendix H.

Spawning Biomass

FMP 1 is projected to have an insignificant impact on spawning biomass compared to the baseline. FMP 1 assumptions are intended to replicate baseline conditions, in which biomass tends toward levels that maintain the ability of the BSAI and GOA sablefish stocks to sustain themselves above the MSST. Spawning biomass decreases from 2002-2007 under FMP 1 because the strong 1997 year-class is decreasing in abundance and is the only strong year-class among recent recruitments.

Spawning biomass is projected to decrease from 2002-2007 while total biomass is projected to increase during the same interval. Total biomass includes ages 2-30+ while spawning biomass includes ages 6.5-30+ (initial age is average age of first spawning for females) so that spawning biomass trends due to changing recruitment lag total biomass trends. Spawning biomass will likely increase for a longer projection. Model projections of future BSAI and GOA spawning biomasses are shown in Tables H.4-11 and H.4-30 of Appendix H.

Spatial/Temporal Concentration of Catch

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. FMP 1 assumptions are intended to replicate baseline conditions.

Habitat Suitability

Because fishing practices under FMP 1 would be similar baseline conditions, it is unlikely that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success sufficient to jeopardize the ability of the BSAI and GOA sablefish stocks to sustain themselves at or above the MSST. Therefore, the direct and indirect effects of FMP 1 on sablefish habitat suitability are expected to be insignificant.

Prey Availability

It is unlikely that FMP 1 would introduce changes in predator-prey interactions sufficient to affect the ability of the BSAI and GOA sablefish stocks to maintain themselves at or above the MSST, because status quo fishing practices would continue under this FMP. Therefore, the direct and indirect effects of FMP 1 on prey availability for sablefish are expected to be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on Sablefish

All direct and indirect effects are found to be insignificant for sablefish under FMP 1.

Status Determination from Modeling

Modeling projections for 2003-2007 suggest that under FMP 1, the future status of EBS and GOA sablefish stocks would be as follows for key indicators.

Catch Relative to ABC

FMP 1 is projected to have an insignificant impact on average sablefish yield compared to the baseline. Yields similar to current levels are projected because FMP 1 assumptions are intended to replicate baseline conditions. Under FMP 1, therefore, sablefish would not be overfished or approach an overfished condition.

Age and Size Composition

FMP 1 is projected to have an insignificant impact on sablefish mean age relative 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 BSAI and GOA. 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 relative to the baseline.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are shown in Table 4.5-5.

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 1 (see Section 4.5.1.3 direct/indirect effects discussion).

- **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 Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of sablefish are predicted to continue in the IPHC longline and State of Alaska groundfish fisheries, 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 sufficient to jeopardize the capacity of the stock to produce MSY on a continuing basis. Climate changes and regime shifts are not identified as being contributors to direct sablefish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of sablefish, but the effect 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 1 (see Section 4.5.1.3 direct/indirect Effects discussion).

- **Persistent Past Effects.** While past large removals of sablefish and other past effects on biomass have been identified (see Section 3.5.1.3), 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 on the change in biomass is identified; however, the effect is 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 1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population. Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. FMP 1 assumptions are intended to replicate baseline conditions.

- **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 directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline, State of Alaska groundfish, 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 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 1 would be governed by a complex web of direct and indirect interactions which 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 catch and bycatch of sablefish prey species in past foreign and domestic and state fisheries 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 Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on sablefish prey species are unknown; however, 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 Section 3.5.1.3). 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 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.** 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 1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish habitat suitability.

- **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 fishery, and climate changes and regime shifts (see Section 3.5.1.3). 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 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **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. Impacts on habitat from climate changes and regime shifts on the sablefish 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.** Cumulative effects are identified for habitat suitability; however, those effects on the sablefish 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 sablefish stock to sustain itself at or above MSST is jeopardized.

4.5.1.4 Atka Mackerel

Numerous fishery management actions have been implemented that affect the Atka mackerel fisheries in the BSAI and GOA. These actions are described in more detail in Sections 3.5.1.4 and 3.5.1.18 of this Programmatic SEIS. Atka mackerel is managed as separate stocks in the BSAI and GOA; in the BSAI it falls under Tier 3a of the ABC and OFL definitions. However, in the GOA this target species is managed under Tier 6.

Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI and GOA Atka mackerel. All direct and indirect effects of FMP 1 on BSAI Atka mackerel are expected to be insignificant. The potential effects on the GOA stock are unknown. Significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 1 assume the maximum permissible F according to Amendment 56 ABC/OFL definitions. Currently, BSAI Atka mackerel are harvested at a more conservative rate than the maximum allowable, but the rates have varied as set by the NPFMC. Given the difficulty in predicting the future ABC levels to be set by the NPFMC, the projections assume the default Amendment 56 values. Therefore, under FMP 1, projections may suggest higher than expected catches and lower than expected biomass levels, at least in the very short-term.

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

<u>Fishing Mortality</u>

The average expected yield for BSAI Atka mackerel during the period 2003-2007 is 62,700 mt (Table H.4-17 of Appendix H). The catch and ABC values, which are nearly 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 0.436 in 2004, then decrease in 2005 and increase to 0.401 in 2007. Overall, the projections show a 60 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the F_{MSY} proxy ($F_{35\%}$) value of 0.564, which is the rate associated with the OFL. Therefore, the projected Fs for BSAI Atka mackerel under FMP 1 are considered to be insignificant, because they would not jeopardize the capacity of the stocks to produce MSY on a continuing basis.

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 as a conservative measure to accommodate the lack of a reliable current estimate of biomass, and to recognize that GOA Atka mackerel may be particularly vulnerable to fishing pressure because of its patchy distribution and sporadic recruitment patterns (Lowe *et al.* 2002).

Projections of GOA Atka mackerel under FMP 1 indicate that catches will likely average 100 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). Because data on which to establish a reliable current estimate of biomass for GOA Atka mackerel are lacking, the effects of fishing mortality on Atka mackerel under FMP 1 are unknown.

<u>Change in Biomass Level</u>

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 1, model projections indicate that total BSAI Atka mackerel is expected to decline to a value of 415,000 mt by 2005, then increase to a value of 442,000 mt by 2007, with a 2003-2007 average value of 435,000 mt. Overall, the projections show an 8 percent decrease in total biomass from 2002 to 2007 under FMP 1. This projected decrease is considered to be insignificant, because total Atka mackerel biomass in the BSAI would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. Potential effects of FMP 1 on GOA Atka mackerel total biomass are unknown, because reliable estimates of the current total biomass are not available to support modeling.

Spawning Biomass

Spawning biomass of female 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 1, model projections indicate that BSAI spawning biomass is expected to decline to a value of 78,500 mt by 2005, then increase to a value of 88,000 mt by 2007, with a 2003-2007 average value of 88,900 mt. Overall, the projections show about a 26 percent decrease in female spawning biomass from 2002 to 2007 under FMP 1. Projected spawning biomass exceeds the B_{MSY} proxy value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007). Although the BSAI Atka mackerel spawning biomass is projected to decline, it would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. Therefore, this potential effect under FMP 1 is considered to be insignificant. Potential effects of FMP 1 on GOA Atka mackerel spawning biomass are unknown, because reliable estimates of the current spawning biomass are not available to support modeling.

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

Under FMP 1, the current network of spatial/temporal closed areas would remain in place. The closures designated in the Steller sea lion protection measures would 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 are in place which have the effect of spreading out the harvest in time and space. The overall BSAI TAC is allocated to three management areas (Western, Central, and Bering Sea/Eastern Aleutians). 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. The temporal/spatial concentration of the catch under FMP 1 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. Under FMP 1, therefore, the spatial and temporal pattern of catch concentration would have an insignificant effect on BSAI Atka mackerel relative to the baseline.

Because population data are lacking on the GOA Atka mackerel stock, its MSST is unknown. Therefore, the potential effects of the spatial and temporal pattern of catch on this stock under FMP 1 are unknown.

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with BSAI 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 1 does not appear likely to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Therefore, impacts on habitat suitability for BSAI Atka mackerel would be insignificant under FMP 1. It is not known what effect implementation of FMP 1 would have on habitat suitability for GOA Atka mackerel, although fishing practices would be similar to those under the status quo.

Prey Availability

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions which 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 1. 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. The current levels and distribution of harvest do not appear to affect prey availability in ways that impair the ability of the stock to maintain itself above its MSST. Therefore, it is likely that potential effects of FMP 1 on prey availability for BSAI and GOA Atka mackerel would be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on Atka Mackerel

The criteria used to estimate the significance of potential effects of the FMPs on the BSAI and GOA stocks of Atka mackerel are outlined in Section 4.1.1.1. The expected direct and indirect effects of FMP 1 on BSAI and GOA Atka mackerel are summarized in Appendix A, Table 4.5-83. Potential direct and indirect impacts of FMP 1 on the BSAI and GOA Atka mackerel stocks are rated as either insignificant or unknown. The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis, as the model projections could yield only results that were deemed significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overF (F_{OFL}), the MSST for the fishing mortality effect, and the MSST for all other effects as the bases for evaluating the potential impacts of FMP 1 on Atka mackerel. Because the mean projected BSAI Atka mackerel Fs are below the overF, and the spawning stock is above its MSST in each of the projection years (2003-2007), the fishing mortality effect of FMP 1 is rated as insignificant. As noted above, the spawning stock biomass of BSAI Atka mackerel in each of the projection years (2003-2007) is above $B_{35\%}$ (B_{MSY} proxy), and therefore the BSAI Atka mackerel stock is determined to be above its MSST under FMP 1. For all other direct and indirect effects, it was determined that FMP 1 would not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST, and the effects were accordingly rated as insignificant.

Relative to the comparative baseline under FMP 1, 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 just above the 2007 level of 88,000 mt.

The F and the MSST for GOA Atka mackerel are unknown, and thus the effect of fishing mortality is unknown under FMP 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 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 1 will not affect prey availability for BSAI or GOA Atka mackerel, and the potential impact on prey availability is considered to be insignificant.

Relative to the baseline, the GOA Atka mackerel stock under FMP 1 is likely to remain at a low abundance with continued low exploitation as a bycatch fishery only.

Status Determination from Modeling

Modeling projections for 2003-2007 suggest that under FMP 1, the future status of EBS and GOA atka mackerel stocks would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI Atka mackerel are below the overfishing level in all years under FMP 1 (Table H.4-17 of Appendix H). Female spawning biomass in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy). These indicators suggest that the BSAI Atka mackerel stock is not overfished and is above its MSST under FMP 1.

GOA Atka mackerel are in Tier 6, and the MSST is unknown. Therefore, a status determination cannot be made for this stock.

Age and Size Composition

Under FMP 1, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.74 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 Fs could cause a shift in the age and size compositions.

Because the level of catch of GOA Atka mackerel is very low and projected to remain at the same low level under FMP 1, it is unlikely that the age and size compositions would change in the future under this FMP. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variations in recruitment than by 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 under FMP 1. 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 under FMP 1 are unknown.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are shown in Tables 4.5-6 and 4.5-7. For further information regarding persistent past effects listed below in the text and in the tables, see the past/present effects analysis section of Sections 3.5.1.4 and 3.5.1.18.

BSAI Atka Mackerel

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 1 (see Section 4.5.1.4 direct/indirect effects discussion).

- **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 1 is identified for mortality of BSAI Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the MSS. 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 Atka mackerel stock is expected to be insignificant under FMP 1 (see Section 4.5.1.4 direct/indirect effects discussion).

- **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; however, 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.** As described under the internal effects section, the temporal/spatial concentration of the catch under FMP 1 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.

- **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 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 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.** As described above under the direct/indirect effects section, the current levels and distribution of harvest do not appear to impact prey availability such that it affects 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.

- **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; however, 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.** As described in the direct/indirect effects section above, the level of habitat disturbance caused by the fishery under FMP 1 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.

- **Persistent Past Effects.** Past effects are 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 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **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, that effect on the BSAI Atka mackerel 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 Atka mackerel stock to sustain itself at or above MSST is jeopardized.

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.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under FMP 1. The F and the MSST for GOA Atka mackerel are unknown; thus the effect of fishing mortality is unknown under FMP 1 (see Section 4.5.1.4, direct/indirect effects discussion).

- **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 3.5.1.4).

- **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 1 is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and its 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 FMP 1. Current reliable estimates of total and spawning biomass are unknown for GOA Atka mackerel (see Section 4.5.1.4, direct/indirect effects discussion).

- **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 3.5.1.4).

- **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; 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 FMP 1 (see Section 4.5.1.4, direct/indirect effects discussion).

- **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 3.5.1.4).

- **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. 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 1 will not impact prey availability for BSAI Atka mackerel and the impact to the prey availability effect is determined to be insignificant (see Section 4.5.1.4, direct/indirect effects discussion).

- **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 3.5.1.4).

- **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.** A cumulative effect is not identified for prey availability; however, the effects are 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 1 (see Section 4.5.1.4, direct/indirect effects discussion).

- **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 3.5.1.4). 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 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **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, their significance on the GOA Atka mackerel stock is unknown.

4.5.1.5 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 Sections 3.5.1.5 and 3.5.1.19 of this Programmatic SEIS. Yellowfin sole is managed as its own stock under the BSAI groundfish FMP in 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. Yellowfin sole is included in this group, along with northern and southern rock 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 (Turnock *et al.* 2001). The shallow water group is managed as Tier 4 and Tier 5 species in the GOA.

As discussed in the following subsections, all potential direct and indirect effects of FMP 1 on this group are expected to be insignificant. External effects associated with the FMP 1 are shown in Tables 4.5-8 and 4.5-9 of Appendix A. For further information regarding persistent past effects listed below in the text and in Tables 4.5-8 and 4.5-9, see the past/present effects analysis discussion in Sections 3.5.1.5 and 3.5.1.19.

BSAI Yellowfin Sole – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI yellowfin sole. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Model projections show that under FMP 1, this value would increase to 0.099 in 2006 and 2007 (Table H.4-4 of Appendix H). This value is well below the F_{MSY} proxy value of 0.138, the rate associated with the overfishing level. Because the capacity of the stock to produce MSY on a continuing basis would not be jeopardized under these conditions, the direct effect of FMP 1 on the mortality rate of BSAI yellowfin sole from fishing is expected to be insignificant.

Change in Biomass Level

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 1, model projections indicate that the total BSAI biomass is expected to decline by slightly more than 2 percent of the 2002 value to 1,520,000 mt by 2007, with a 2003-2007 average value of 1,531,000 mt. This projected decrease is considered to be insignificant, because total yellowfin sole biomass in the BSAI would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST.

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. Under FMP 1, model projections indicate that female spawning biomass is expected to decline by nearly 10 percent of the 2002 value to 409,000 mt by 2007, with a 2003-2007 average value of 433,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the five-year projection. Although the BSAI yellowfin sole spawning biomass is projected to decline, it would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. Therefore, this potential effect under FMP 1 is considered to be insignificant.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI yellowfin sole harvest, relative to the 2002 baseline, would not be affected under FMP 1. Therefore, this potential impact is considered to be insignificant, because it is not likely to cause changes in genetic structure or reproductive success that would jeopardize the ability of the stock to maintain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which 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. Because fishing practices under FMP 1 would be similar to the status quo, however, it is unlikely that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success sufficient to jeopardize the ability of the stock to sustain itself at or above the MSST. Therefore, any direct or indirect effects of FMP 1 on BSAI yellowfin sole habitat suitability are expected to be insignificant.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on BSAI yellowfin sole would be governed by a complex web of indirect interactions which 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 1. The current levels and distribution of harvest do not appear to affect prey availability in ways that impair the ability of the stock to maintain itself above its MSST, however, it is likely that potential effects of FMP 1 on prey availability for BSAI yellowfin sole would be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Yellowfin Sole

Appendix A, Table 4.5-83 summarizes the expected effects of FMP 1 on BSAI yellowfin sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis, because the model yields projections that can be classified only as significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize F_{OFL} and the MSST as a basis for predicting beneficial or adverse impacts on fishing mortality and reproductive success, respectively, 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 1, the spawning stock biomass of BSAI yellowfin sole is expected to be above the MSST. The fishing mortality does not exceed F_{OFL}, and the female spawning stock is currently above the MSST; therefore, the expected changes under this FMP would not be substantial enough to change the genetic diversity or reproductive success of the spawning stocks. For this reason, the potential indirect and direct effect sof this FMP on BSAI yellowfin sole are considered insignificant.

Relative to the 2002 comparative baseline, the yellowfin sole stock is not projected to be continually overfished under this FMP. The 20-year projection indicates that the female spawning stock would decline to B_{ABC} levels until 2010 and increase thereafter through the end of the projection in 2023.

Status Determination from Modeling

Model projections for 2003-2007 indicate that under FMP 1, the future status of the BSAI yellowfin sole stock would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI yellowfin sole are below the OFLs in all years under FMP 1. The yellowfin sole stock is above the MSST level in 2002 (Table H.4-4 of Appendix H).

Age and Size Composition

Under FMP 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 6.2 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.0 years. Note that the mean age and size actually observed in 2008 (as opposed to the model projections) 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 1.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are shown in Table 4.5-8.

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI yellowfin sole is rated as insignificant under FMP 1 (see the direct/indirect effects discussion above).

- **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 identified for mortality of BSAI yellowfin 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.

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** As described in the direct/indirect effects section, it is not expected that FMP 1 will result in any significant adverse impact to these stocks.

- **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 potentially 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 Sections 3.5.1.5 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI yellowfin 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.

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

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

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see the direct/indirect effects discussion).

- **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. 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 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 possible for the spatial/temporal concentration of the yellowfin sole catch; however, 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.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI yellowfin sole is ranked as insignificant (see the direct/indirect effects discussion).

- **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 Sections 3.5.1.5 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. 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 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 1, the change in habitat suitability for the BSAI yellowfin sole is ranked as insignificant. Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 1 would have insignificant effects on yellowfin sole habitat suitability (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects 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 Sections 3.5.1.5 and 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. 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 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; however, 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 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on the GOA shallow water flatfish complex. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing 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 1, model projections indicate that the catch is expected to decrease from the 2002 value to 5,400 mt in 2003-2006 and to 5,100 mt in 2007. The 2003-2007 average catch is projected to be 5,300 mt under FMP 1. Although information necessary to determine MSY is lacking for shallow water flatfish, the projected decrease in catch under this FMP suggests that effects of fishing mortality are likely to be insignificant, because they would not be expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

No reliable estimates for total or spawning biomass are available for GOA shallow water flatfish. Therefore, potential effects of FMP 1 relating to changes in biomass are unknown for this group.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA shallow water flatfish harvest under FMP 1 would be similar to baseline conditions. However, evidence is insufficient to conclude whether spatial and temporal patterns of harvest concentration would lead to a detectable change in genetic diversity or reproductive success, and MSSTs have not been established for the species in this group. Therefore, any potential effects of the spatial/temporal concentration of the catch on shallow water flatfish under this FMP are unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which 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, and MSSTs have not been defined for the shallow water flatfish species. Therefore, potential effects of FMP 1 on habitat suitability for this group are unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on shallow water flatfish would be governed by a complex web of indirect interactions which 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 nor have MSSTs been defined for the shallow water flatfish species. Therefore, potential effects of FMP 1 on prey availability for this group are unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Shallow Water Flatfish

The direct and indirect effects of FMP 1 on GOA shallow water flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. Available information is insufficient to estimate female spawning biomass of these stocks over the five-year projection and what level of fishing mortality would correspond to the modeled catch estimated under this FMP. Because catch volumes are predicted to decline moderately over the five-year period, the effect of FMP 1 on fishing mortality is likely to be insignificant. All other direct and indirect effects of FMP 1 on the shallow water flatfish complex are unknown, because available information on the stocks is insufficient to determine MSSTs.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for flatfish species in the shallow water complex requires that they be 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 the status of their stocks relative to MSST.

Age and Size Composition

Under FMP 1, the mean age of the GOA shallow water flatfish stock in 2008, as computed in model projections, is 4.7 years. This compares with a mean age in the equilibrium unfished GOA 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 shallow water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-9 summarizes the cumulative effects analysis for GOA shallow water flatfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under FMP 1 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past, JV, and domestic fisheries have been identified as having lingering past adverse effects on th GOA shallow water flatfish complex. See Section 3.5.1.19 for more information.

- **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 by catch 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 1 on change in biomass are unknown (see the direct/indirect effects discussion).

- **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 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution; acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse contributions on the shallow water flatfish species 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 3.5.1.19 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 and external 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 will not be affected under FMP 1, relative to the 2002 baseline year. However, little is known about the spatial/temporal characteristics of GOA shallow water flatfish, therefore the effects of FMP 1 are rated as unknown (see the direct/indirect effects discussion).

- **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 (see Section 3.5.1.19).

- **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 potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock complex. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. 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 GOA shallow water flatfish. The 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 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.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the GOA shallow water flatfish is determined to be unknown (see the direct/indirect effects discussion).

- **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 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse. 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 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. The State of Alaska scallop fishery is identified as a non-contributing factor since by catch 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 1 on shallow water flatfish are governed by a complex web of indirect interactions which are currently difficult to quantify.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be unknown. Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for GOA shallow water flatfish 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 Sections 3.5.1.19 and 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 potentially beneficial or adverse. 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 contribution 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 also identified as a potential adverse contributor to GOA shallow water flatfish habitat suitability. See Section 3.6.4 for information of the impacts of fishery gear on EFH.

- **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.

4.5.1.6 Rock Sole

Numerous fishery management actions have been implemented that affect the rock sole fisheries in the BSAI. These actions are 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 as a Tier 3 management category; therefore, an MSST is defined for this species.

Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI rock sole. As discussed below, all potential direct and indirect effects of FMP 1 on this group are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.055. Model projections suggest this value will increase to 0.137 in 2007 (Table H.4-7 of Appendix H). These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL. Therefore, the projected Fs for BSAI rock sole under FMP 1 are considered to be insignificant, because they would not jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

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 1, the 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 765,000 mt. This projected decrease is considered to be insignificant, because total rock sole biomass in the BSAI would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST.

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 of Appendix H. Under FMP 1, model projections indicate that female spawning biomass is expected to decline to 53 percent of the 2002 value to 175,900 mt by 2007, with a 2003-2007 average value of 238,100 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the five-year projection. Although spawning biomass for BSAI rock sole is projected to decline, it would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. Therefore, this potential effect under FMP 1 is considered to be insignificant.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI rock sole harvest, relative to the 2002 baseline year, would not be affected under FMP 1. The temporal/spatial concentration of the catch under baseline conditions 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. Under FMP 1, therefore, the spatial and temporal pattern of catch concentration would have an insignificant effect on BSAI rock sole relative to the baseline.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 on BSAI rock sole would be governed by a complex web of direct and indirect interactions which 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. The level of habitat disturbance caused by the fishery under baseline conditions does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Therefore, impacts on habitat suitability for BSAI rock sole are expected to be insignificant under FMP 1.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on rock sole would be governed by a complex web of indirect interactions which 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 1. The current levels and distribution of harvest do not appear to affect prey availability in ways that impair the ability of the rock sole stock to maintain itself above its MSST. Therefore, it is likely that potential effects of FMP 1 on prey availability for BSAI rock sole would be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Rock Sole

Appendix A, Table 4.5-83 summarizes the expected direct and indirect effects of FMP 1 on BSAI rock sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis, because the model projections yielded results that could be evaluated only as significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize F_{OFL} and MSST as the bases for identifying potentially beneficial or adverse impacts on fishing mortality and reproductive success under 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 1, the spawning stock biomass of BSAI rock sole is expected to be above the MSST. Since the F would not exceed F_{OFL} and the stock is expected to remain above the MSST, the expected changes under this FMP would not be substantial enough that the genetic diversity or reproductive success of the spawning stocks would be likely to change under the new management regime. Therefore, the potential direct and indirect effects on BSAI rock sole under this FMP are considered insignificant.

Relative to the 2002 comparative baseline, the rock sole stock is projected to continue not to be overfished under this FMP. The 20-year projection indicates that the female spawning stock is expected to decline to a level just less than B_{MSY} in 2010, then increase to above B_{ABC} levels by 2015, and continue to increase through the end of the projection in 2023.

Status Determination from Modeling

Model projections for 2003-2007 suggest that under FMP 1, the future status of the BSAI rock sole stock would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI rock sole are below the OFLs in all years under FMP 1, and the female spawning stock is above the MSST. The rock sole stock is projected to be above the MSST level in 2002.

Age and Size Composition

Under FMP 1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.7 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean age and size 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 1.

Cumulative Effects of FMP 1

Table 4.5-10 summarizes the cumulative effects analysis for BSAI rock sole.

<u>Mortality</u>

- **Direct/Indirect Effects.** As stated above in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under FMP 1.

- **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; 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.

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI rock sole biomass is rated as 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 contribution of marine pollution; acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts have also been identified as having potentially 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 potentially beneficial or adverse. 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 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 affect the availability of some forage species (i.e. capelin); however, studies on benthic invertebrates have not been conducted. See Section 3.5.1.6 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potentially 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 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.

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 potentially 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; however, this effect 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.

4.5.1.7 Flathead Sole

Numerous fishery management actions have been implemented that affect the flathead sole fisheries in the BSAI and GOA. These actions 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 within the Tier 3 management category; therefore, an MSST is defined for this species by the National Standard Guidelines. Beginning in 2002, flathead sole were managed independently of the other flatfish species in the GOA. Until recently, GOA flathead sole were evaluated under the Tier 4 management category; beginning in 2004, flathead sole will be 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 1

The following discussions briefly describe the analyses of direct and indirect impacts of FMP 1 on BSAI flathead sole. As discussed below, all of these potential effects are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The projected fishing mortality imposed on the BSAI flathead sole stock in 2003 is 0.047. Model projections suggest that under FMP 1, this fishing mortality would increase to 0.086 in 2008, with an average fishing mortality of 0.063 from 2003-2008 (Table H.4-8 of Appendix H). These values are below the $F_{35\%}$ level of 0.355 and the $F_{40\%}$ level of 0.286, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. The proportion of spawner biomass per recruit conserved under these mortality rates is 80 percent in 2003, decreasing to 70 percent in 2008; the average implied spawner biomass per recruit (SPR) rate of fishing from 2003-2008 is 76 percent. These projections indicate that the expected effects of FMP 1 on BSAI flathead sole mortality are likely to be insignificant, because they would not jeopardize the capacity of the stocks to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

Total biomass (ages 3 through 21+) of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future BSAI total flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 490,000 mt in 2006, then increase to 498,000 mt in 2008. The 2003-2008 projected average total biomass is 497,000 mt. These projections indicate that the total flathead sole biomass in the BSAI would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. For this reason, the impact of FMP 1 on BSAI flathead sole total biomass is expected to be insignificant.

Spawning Biomass

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 231,200 mt. Model projections of future total BSAI flathead sole spawning biomass are shown in Table H.4-8 of Appendix H. Under FMP 1, model projections indicate that BSAI flathead sole spawning biomass would increase to a value of 164,600 mt in 2008, with a 2003-2008 average value of 196,000 mt. Under FMP 1, therefore, impacts on BSAI flathead sole spawning biomass are expected to be insignificant, because the existing ability of the stock to sustain itself above the MSST would be maintained.

Spatial/Temporal Concentration of Catch

The harvest of flathead sole occurs largely along the western edge of the EBS shelf; little harvest occurs in the Aleutian Islands. Although some directed fishing for flathead sole exists, a considerable amount of harvest occurs as bycatch in other target fisheries. Under FMP 1, an average of 12,900 mt is projected to be harvested annually from 2003-2008, almost entirely from the EBS. The EBS Pacific cod and yellowfin sole fisheries account for 3,240 mt (25 percent) and 2,530 mt (19 percent) of the average annual harvest, whereas the directed flathead sole fishery accounts for 1,910 mt (15 percent). Recent observer data indicate that the harvest of flathead sole occurs year-round, and is determined largely from the seasonal allocations of the Pacific halibut prohibited species bycatch limits for flatfish trawl fisheries (Spencer *et al.* 2001). Because these patterns would be maintained under FMP 1, the temporal/spatial concentration of the catch would not be likely 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. Therefore, this potential impact is considered to be insignificant.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 1. Therefore, the effects of FMP 1 on BSAI flathead sole habitat suitability are expected to be insignificant, because the present ability of the stock to maintain itself above the MSST would not be impaired.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under this FMP. Since the current levels and distribution of harvest have not been shown to affect prey availability in ways that impair the ability of the stock to maintain itself above its MSST, potential future effects of FMP 1 on prey availability for BSAI flathead sole are likely to be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Flathead Sole

Because BSAI flathead sole are fished at less than the OFL and are above the MSST, the direct and indirect effects of FMP 1 on this stock are considered insignificant. Fishing rates are well within accepted scientific standards based on studies of population dynamics and estimates of natural variations in recruitment. Therefore, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

Relative to the 2002 comparative baseline, the flathead sole stock is projected to continue not tot be overfished under this FMP. The 20- year projection indicates that the female spawning stock would decrease until 2009, then begin to increase steadily through the end of the projection. The female spawning stock is estimated to remain above B_{ABC} throughout the projection.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, 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 BSAI flathead sole are below the ABC and OFL levels in all years. The BSAI flathead sole are above their MSST in the year 2002.

Age and Size Composition

Under FMP 1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections, is 4.53 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 1.

Cumulative Effects of FMP 1

Table 4.5-11 summarizes the cumulative effects analysis for BSAI flathead sole.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under FMP 1.

- **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; 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 fishing on the 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; acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potentially 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, 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 B_{MSY} value. 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 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 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 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 potentially 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.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, 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 potentially 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 1, 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 potentially 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 1

The following discussions briefly describe the analyses of direct and indirect impacts of FMP 1 on GOA flathead sole. The effect of fishing mortality on this stock is expected to be insignificant, whereas the significance of other potential direct and indirect effects is unknown. Significance ratings are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

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 1, model projections indicate that the catch would decrease from the 2002 value to 1,700 mt in 2003 and then further decline to 1,500 mt in 2007 (75 percent of 2002 catch). The 2003-2007 average catch is 1,600 mt. Therefore, the projected Fs for GOA flathead sole under FMP 1 are considered to be insignificant, because they would not jeopardize the capacity of the stocks to produce MSY on a continuing basis.

Change in Biomass Level

Estimates of total and spawning biomass are not available for this species. Therefore, the potential effects of FMP 1 on biomass levels, and any resulting impact on the stock's ability to maintain itself above the MSST, are unknown.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA flathead sole harvest would not be affected under FMP 1, relative to the 2002 baseline year. However, the effects of the temporal/spatial concentration of the catch on this stock under baseline conditions are unknown. Therefore, the potential effects of FMP 1 to affect the stock's genetic structure or reproductive success must also be considered unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 on GOA flathead sole would be governed by a complex web of direct and indirect interactions which 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. Because habitat-mediated impacts under baseline conditions are unknown, however, the potential habitat-mediated effects of FMP 1 on the stock's ability to maintain itself above the MSST must also be considered unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on GOA flathead sole would be governed by a complex web of indirect interactions which 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 1. Because data on prey availability under baseline conditions are not available, however, potential predation-mediated impacts of FMP 1 on the ability of the GOA flathead sole stock to sustain itself at or above the MSST are unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Flathead Sole

Because the GOA flathead sole catch is projected to decrease moderately during the 2003-2007 period, the effect of FMP 1 on fishing mortality is expected to be insignificant. All other direct and indirect effects of FMP 1 on GOA flathead sole are unknown, because they 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 would be over the five-year projection and what level of fishing mortality would correspond to the modeled catch estimated under this FMP.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for flathead sole requires that this species be classified into the Tier 4 management category. As a result, no MSSTs are defined for flathead sole, and it is not possible to determine the status of the stock size relative to MSST.

Age and Size Composition

Age and size composition estimates are not available 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 1.

Cumulative Effects of FMP 1

Table 4.5-12 summarizes the cumulative effects analysis for GOA flathead sole.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under FMP 1.

- **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. For more information, 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; 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 1, 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; acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potentially 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 are 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 1 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 potentially 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 are 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.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 1, 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 potentially 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 1, the change in habitat suitability for the GOA flathead sole is unknown. Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify.

- **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 potentially 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 3.6.4.

- **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.

4.5.1.8 Arrowtooth Flounder

Numerous fishery management actions have been implemented that affect the arrowtooth flounder fisheries in the BSAI and GOA. These actions 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 as part of the Tier 3 management category. Therefore, MSSTs are defined for these stocks.

BSAI Arrowtooth Flounder – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI arrowtooth flounder. All of these potential effects are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015. Model projections show this value will increase to 0.26 in 2007. These values are well below the F_{MSY} proxy value of 0.38, the rate associated with the overfishing level. This impact is expected to be insignificant, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

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 1, model projections indicate that the total BSAI biomass is expected to decline 26 percent of the 2002 value to 597,000 mt by 2007, with a 2003-2007 average value of 675,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

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 of Appendix H. Under FMP 1, model projections indicate that female spawning biomass is expected to decline to 30 percent of the 2002 value to 329,500 mt by 2007, with a 2003-2007 average value of 387,900 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 182,900 mt throughout the five-year projection. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest, relative to the 2002 baseline, would not be affected under FMP 1. This impact is expected to be insignificant, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which 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. Therefore, the effects of FMP 1 on habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on BSAI arrowtooth flounder would be governed by a complex web of indirect interactions which 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 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Arrowtooth Flounder

Under FMP 1, the spawning stock biomass of BSAI arrowtooth flounder is expected to be above the MSST. Since the F 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 this FMP are considered insignificant.

Relative to the 2002 comparative baseline, the BSAI arrowtooth flounder stocks are projected to continue to not be overfished under this FMP. The 20-year projection indicates that the female spawning stock in both areas is expected to remain above B_{ABC} levels through the end of the projection in 2023.

Status Determination from Modeling

Modeling projections for 2003-2007 indicate that under FMP 1, the future status of BSAI arrowtooth flounder would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI arrowtooth flounder are below the overfishing levels in all years under FMP 1. The arrowtooth flounder female spawning biomass is above the MSST level in 2002.

Age and Size Composition

Under FMP 1, 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 1.

Cumulative Effects of FMP 1

Table 4.5-13 summarizes the cumulative effects analysis for BSAI arrowtooth flounder.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI arrowtooth flounder is rated as insignificant under FMP 1.

- **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; 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.

<u>Change in Biomass Level</u>

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

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts have also been identified as having potentially 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 Sections 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 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 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 potentially 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 spatial/temporal distribution of arrowtooth flounder 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 1, 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, domestic fisheries, State of Alaska groundfish fisheries, State of Alaska herring fisheries, and climate changes and regime shifts. See Section 3.5.1.8 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potentially 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 1, 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 potentially 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 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA arrowtooth flounder. All of these potential effects are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017. Model projections show this value will decrease to 0.009 in 2007. These values are well below the F_{MSY} proxy value of 0.165, the rate associated with the overfishing level. This impact is expected to be insignificant, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

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 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. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

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 GOA arrowtooth flounder spawning biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 1, model projections indicate that female spawning biomass is expected to increase 4 percent of the 2002 value to 1,115,700 mt by 2007, with a 2003-2007 average value of 1,142,300 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the five-year projection. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest, relative to the 2002 baseline, would not be affected under FMP 1. Therefore, this impact is expected to be insignificant, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which 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. Therefore, the effects of FMP 1 on habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on GOA arrowtooth flounder would be governed by a complex web of indirect interactions which 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 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Arrowtooth Flounder

Under FMP 1, the spawning stock biomass of GOA arrowtooth flounder is expected to be above the MSST. Since the F 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. Therefore, the indirect and direct effects under this FMP are considered insignificant.

Relative to the 2002 comparative baseline, the GOA arrowtooth flounder stocks are projected to continue not to be overfished under this FMP. The 20-year projection indicates that the female spawning stock in both areas is expected to remain above B_{ABC} levels through the end of the projection in 2023.

Status Determination from Modeling

Model projections of future catches of GOA arrowtooth flounder are below the overfishing levels in all years under FMP 1. The arrowtooth flounder female spawning biomass is above the MSST level in 2002.

Age and Size Composition

Under FMP 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. 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 for females. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-14 summarizes the cumulative effects analysis for GOA arrowtooth flounder.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA arrowtooth flounder is rated as insignificant under FMP 1.

- **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 the biomass level is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for 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 arowtooth 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 1 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.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, 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 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey availability are the same as those discussed 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.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA arrowtooth flounder include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.21.

- **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.

4.5.1.9 Greenland Turbot and Deepwater Flatfish

The numerous fishery management actions that affect the Greenland turbot fisheries in the BSAI are described in more detail in Section 3.5.1.9 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 by the National Standard Guidelines. The reference F 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 exists. Section 3.5.1.22 discusses the past/present effects analysis for GOA deepwater flatfish.

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI Greenland turbot. All of these impacts are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Model projections indicate that under this FMP the F will reach a maximum in 2004 of 0.19 and decrease thereafter to 0.162 by 2007. These values are well below the F_{MSY} proxy value of 0.48, the rate associated with the OFL. This impact is expected to be insignificant, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

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 1, model projections indicate that the total BSAI biomass is expected to decline 19 percent of the 2002 value to 86,000 mt by 2007, with a 2003-2007 average value of 92,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

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 1, model projections indicate that female spawning biomass is expected to decline to 31 percent of the 2002 value to 46,800 mt by 2007, with a 2003-2007 average value of 54,100 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,600 mt in the first four years of the projection, and would be below the B_{MSY} proxy rate in 2007. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI Greenland turbot harvest, relative to the 2002 baseline, would not be affected under FMP 1. This impact is expected to be insignificant, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which 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. Therefore, the effects of FMP 1 on habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on Greenland turbot would be governed by a complex web of indirect interactions which 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 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Greenland Turbot

Under FMP 1, the spawning stock biomass of BSAI Greenland turbot is expected to be above the MSST. Since the F does not exceed F_{OFL} and the 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.

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to continue not to be overfished under this FMP. The 20-year projection 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 to be above B_{ABC} in 2023.

Status Determination from Modeling

Stock Size Relative to MSST

Model projections of future catches of BSAI Greenland turbot are below the OFLs in all years under FMP 1. The Greenland turbot stock is above the MSST level in 2002.

Age and Size Composition

Under FMP 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 4.6 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 1.

Cumulative Effects Analysis of FMP 1

Table 4.5-15 summarizes the cumulative effects analysis for BSAI Greenland Turbot.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 1.

- **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; 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 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 the change in 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 are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts have also been identified as having potentially 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 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 1 the effect of the spatial/temporal concentration of catch is considered insignificant 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 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potentially 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 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 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 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potentially 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 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 for more information on the persistent past effects on Greenland turbot.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potentially 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 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.

GOA Deepwater Flatfish – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on the GOA deepwater flatfish complex. The potential effect of FMP 1 on this complex through fishing mortality is expected to be insignificant. The significance of all other potential direct and indirect effects on this group is unknown. Significance ratings are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

<u>Fishing Mortality</u>

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 1, model projections indicate that the catch is expected to increase two and a half times the 2002 value to 1,600 mt by 2007, with a 2003-2007 average value of 1,600 mt. This impact is expected to be insignificant, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass Level</u>

Reliable estimates of total and spawning biomass do not exist for these species. Consequently, the potential impact of FMP 1 on GOA deepwater flatfish biomass levels is unknown, because MSSTs have not been determined for the species in this group.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA deepwater flatfish harvest would not be affected under FMP 1, relative to the 2002 baseline. However, the effects of the temporal/spatial concentration of the catch on this stock under baseline conditions are unknown. Therefore, the potential effects of FMP 1 to affect genetic structure or reproductive success within the GOA deepwater flatfish populations must also be considered unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 on the GOA deepwater flatfish complex would be governed by a complex web of direct and indirect interactions which 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. Therefore, evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST under FMP 1.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on deepwater flatfish would be governed by a complex web of indirect interactions which 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 1. Therefore, evidence is insufficient to conclude whether future harvest levels and distribution of harvest under this FMP would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Deepwater Flatfish

The direct and indirect effects of FMP 1 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 would be over the five-year projection and what level of fishing mortality would correspond to the modeled catch estimated under this FMP.

Status Determination from Modeling

Stock Size Relative to MSST

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 in the National Standard Guidelines. Therefore, it is not possible to determine the status of their stock size relative to MSST.

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 1.

Cumulative Effects of FMP 1

Table 4.5-16 summarizes the cumulative effects analysis for GOA deepwater flatfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deepwater flatfish is rated as insignificant under FMP 1.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; 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 1 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; acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts have also been identified as having potentially 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.** A cumulative effect is 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 1 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 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 GOA deepwater flatfish due to climate changes and regime shifts are potentially 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.** A cumulative effect is possible for the spatial/temporal concentration of the GOA deepwater flatfish catch; however, this effect 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 1, the change in prey availability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Past 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 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potentially 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 3.6.4 for information of the impacts of fishery gear on EFH.

- **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 maintain current populations.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, 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 for more information on the persistent past effects on deepwater flatfish.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potentially 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 3.6.4 for more information on the impacts of fishery gear on EFH.

- **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.

4.5.1.10 Alaska Plaice and Other Flatfish and Rex Sole

The numerous fishery management actions that have affected the Alaska plaice, other flatfish, and rex sole fisheries in the BSAI and GOA are described in more detail in Sections 3.5.1.10 and 3.5.1.23 of this Programmatic SEIS.

Alaska plaice is evaluated under Tier 3a of Amendment 56 (Spencer *et al.* 2002b). Estimates of MSST are available for this stock. Although there are fifteen species considered as part of the "other flatfish" complex, only seven species comprise the majority of the catch. The other flatfish assemblage is managed under Tier 5, although it has been managed under Tier 4 and 3a in the past (Spencer *et al.* 2002a). Estimates of MSST are not available for this stock. The reference F and ABC for rex sole are determined by the amount of population information available. ABCs are calculated using F_{ABC} = 0.75 M and F_{OFL} = M (Tier 5), because maturity information is not available.

BSAI Alaska Plaice – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI Alaska plaice. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The projected fishing mortality imposed on the BSAI Alaska plaice stock in 2003 is 0.017. Model projections show this fishing mortality will remain at this level through 2005,then increase to 0.021 in 2006 and 2007, and lower to 0.019 in 2008 (Table H.4.9 of Appendix H). These values are below the $F_{35\%}$ level of 0.344 and the $F_{40\%}$ level of 0.279, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. The proportion of SPR conserved under these mortality rates is 92 percent in 2003, decreases to 90 percent in 2006, and increases to 91 percent in 2008. The average implied SPR rate of fishing from 2003-2008 is 91 percent. The impact of fishing mortality on BSAI Alaska plaice is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

Total biomass (ages 1 through 25+) of BSAI Alaska plaice at the start of 2003 is estimated to be 1,083,000 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4.9 of Appendix H. Under FMP 1, model projections indicate that BSAI biomass is expected to increase to a value of 1,121,000 mt in 2008, with a 2003-2008 average value of 1,104,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 275,900 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4.9 of Appendix H. Under FMP 1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 283,300 mt in 2008, with a 2003-2008 average value of 278,800 mt. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

Alaska plaice is a relatively low-valued flatfish species that is taken as bycatch on the EBS shelf; little harvest occurs in the Aleutian Islands. Under FMP 1, an average of 10,500 mt is projected to be harvest annually from 2003-2008, coming nearly entirely from the EBS. The EBS yellowfin sole and rock sole fisheries account for most of the catch, contributing 7,450 mt (71 percent) and 1,440 mt (14 percent) of the average annual harvest. Recent observer data indicate that the harvest of Alaska plaice occurs year-round, and are determined largely from the seasonal allocations of the Pacific halibut prohibited species bycatch limits for flatfish trawl fisheries (Spencer *et al.* 2001). The impact of the spatial/temporal pattern of the harvest under FMP 1 is expected to be insignificant because the harvest concentration would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the BSAI Alaska plaice stock to sustain itself at or above its MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 1. There is no evidence that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the BSAI Alaska plaice stock to sustain itself at or above the MSST. Therefore, this impact is expected to be insignificant under FMP 1.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 1. There is no evidence that future distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the BSAI Alaska plaice stock to sustain itself at or above the MSST. Therefore, this impact is expected to be insignificant under FMP 1.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Alaska Plaice

Because BSAI Alaska plaice are fished at less than the OFL and are above the MSST, the direct and indirect effects under FMP 1 are considered insignificant. Fishing rates are well 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.

Relative to the 2002 comparative baseline, the Alaska plaice stock is projected to continue not to be overfished under this FMP. The 20-year projection indicates that the female spawning stock is expected to remain at a high and stable level well above B_{ABC}.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, 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 BSAI Alaska plaice are below the ABC and OFL levels in all years. The BSAI Alaska plaice are above their respective MSST in the year 2002.

Age and Size Composition

Under FMP 1, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections, is 4.40 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 1.

Cumulative Effects of FMP 1

Table 4.5-17 summarizes the cumulative effects analysis for BSAI Alaska plaice.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Alaska plaice is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for BSAI Alaska plaice mortality.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause other 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 Alaska plaice. For more information on climate changes and regime shifts, see Sections 3.5.1.10 and 3.10.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Alaska plaice and is rated as insignificant. Fs 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 1, the effect of changes in biomass level is rated as insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass of BSAI Alaska plaice.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause other flatfish mortality. Climate changes and regime shifts have also been identified as having an indirect potentially beneficial or adverse effect on the Alaska plaice biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, whereas when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. For more information on climate changes and regime shifts, see Sections 3.5.1.10 and 3.10.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Alaska plaice and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events is not expected 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 1 the effect of the spatial/temporal concentration of catch is identified as insignificant.

- **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 BSAI Alaska plaice stock. See Sections 3.5.1.10 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 other flatfish include the potential adverse effects of marine pollution; acute and/or chronic pollution events could alter the genetic structure of the population by causing localized mortality. Climate changes and regime shifts have been identified as non-contributing factors to the change in genetic structure of the Alaska plaice stocks. These events are not expected to cause localized depletions that would significantly alter the genetic sub-population structure of the Alaska plaice stock. Change in reproductive success of Alaska plaice due to climate changes and regime shifts is identified as potentially beneficial or adverse. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could also the reproductive success of BSAI Alaska plaice.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Alaska plaice catch and is rated as insignificant. The combined effect of internal removals and external removals are not expected to jeopardize the capacity of the stock to sustain itself above the MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI Alaska plaice is insignificant.

- **Persistent Past Effects.** Climate changes are identified as having effected prey availability of the BSAI Alaska plaice stock. The actual effect of climate changes and regime shifts on Alaska plaice prey availability is unknown, but could have had a potentially beneficial or adverse effect. See Sections 3.5.1.10 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Alaska plaice stock are potentially 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.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events are not expected to jeopardize the capacity of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI Alaska plaice is rated as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI Alaska plaice include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially 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 BSAI Alaska plaice stock See Sections 3.5.1.10 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 BSAI Alaska plaice stock are potentially 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 Alaska plaice habitat suitability and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events is not expected to jeopardize the capacity of the stock to sustain itself above the MSST.

BSAI Other Flatfish – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on the BSAI other flatfish complex. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

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 1, model projections indicate that the catch is expected to decrease from the 2002 value to 2,200 mt in 2003 and then increase each year to 2,500 mt in 2007 (5 percent decrease from 2002). The 2003-2007 average catch is 2,300 mt. The impact of fishing mortality on BSAI other flatfish is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total and spawning biomass estimates are not available for these species. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI other flatfish harvest would not be affected under FMP 1, relative to the 2002 baseline year. Evidence is insufficient to conclude whether the harvest concentration under FMP 1 would lead to a detectable change in genetic diversity or reproductive success that would affect the stock's ability to sustain itself at or above the MSST. Therefore, the impact of the spatial/temporal pattern of the catch on BSAI other flatfish under FMP 1 is unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which 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. Because evidence is not available to determine whether, under FMP 1, future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the BSAI other flatfish stocks to sustain themselves at or above their MSSTs, this potential impact is unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on other flatfish would be governed by a complex web of indirect interactions which 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 1. Consequently, evidence is not available to determine whether future harvest levels and distribution of harvest under this FMP would lead to a change in prey availability that would affect the ability of the BSAI other flatfish stocks to sustain themselves at or above their MSSTs. Therefore, this potential impact is unknown.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Other Flatfish

The direct and indirect effects of FMP 1 on BSAI other 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.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for flatfish species in the other flatfish 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 the status of their stock sizes relative to their MSSTs.

Age and Size Composition

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

Sex Ratio

The sex ratios of the species in the other flatfish category in the BSAI are assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-18 summarizes the cumulative effects analysis for BSAI other flatfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under FMP 1.

- **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. Fs 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 1, 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 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 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.

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under FMP 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 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 identified for the spatial/temporal concentration of catch 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, but 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.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, 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 possible 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 1, 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 are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible 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 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA rex sole. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

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 1, model projections indicate that the catch is expected to increase from the 2002 value to 3,300 mt in 2003and then decrease thereafter to 2,500 mt in 2007. The 2003-2007 average catch is 3,000 mt. The impact of fishing mortality on GOA rex sole is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total and spawning biomass estimates are not available for this species, and the MSST cannot be determined. Therefore, the potential effect of FMP 1 on GOA rex sole biomass levels is unknown.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA rex sole harvest would not be affected under FMP 1, relative to the 2002 baseline year. Evidence is insufficient to conclude whether the harvest concentration under FMP 1 would lead to a detectable change in genetic diversity or reproductive success that would affect the stock's ability to sustain itself at or above the MSST. Therefore, the impact of the spatial/temporal pattern of the catch on GOA rex sole under FMP 1 is unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which 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. The potential impact of FMP 1 is unknown because evidence is not available to determine whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the GOA rex sole stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on rex sole would be governed by a complex web of indirect interactions which 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 1. Therefore, it is unknown whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the GOA rex sole stock's ability to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Rex Sole

The direct and indirect effects of FMP 1 on GOA rex sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. Potential changes in the F would be too small to affect MSY and are therefore considered insignificant. It is unknown what the estimate of female spawning biomass of this stock would be over the five-year projection and what level of fishing mortality would correspond to the modeled catch estimated under this FMP.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for rex sole requires that they are classified in the 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 the status of their stock size relative to MSST.

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 1.

Cumulative Effects of FMP 1

Table 4.5-19 summarizes the cumulative effects analysis for GOA rex sole.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had an 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; 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. Fs 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.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, 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 the change in biomass are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potentially beneficial or adverse effect on the rex sole biomass level. 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 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.

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

- **Direct/Indirect Effects.** Under FMP 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 on 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; 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 is identified as having a potentially 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, 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.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate change and regime shifts have been identified as having effected the change in 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 potentially 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.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potentially 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 benthic prey availability.

- **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. 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 1, 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 potentially 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 potentially 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 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 identified 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.

4.5.1.11 Pacific Ocean Perch

Pacific ocean perch (*Sebastes alutus*) are managed as a single stock in the EBS, Aleutian Islands, and GOA, and separate assessments are made for each region. Within the GOA, ABC limits are apportioned within four management areas in an effort to reduce the risk of localized depletion. Trawl fishing is not permitted in the southeast/east Yakutat area and the ABC (approximately 12 percent of the total GOA ABC) normally allocated to that area is not likely to be caught. Pacific ocean perch are managed under Tier 3 in both the BSAI and GOA.

BSAI Pacific Ocean Perch – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI and GOA Pacific ocean perch. All of these potential effects are expected to be insignificant. The significance ratings are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

<u>Fishing Mortality</u>

The projected fishing mortality imposed on the BSAI Pacific ocean perch stock in 2003 is 0.033. Model projections show this fishing mortality will decrease to 0.027 in 2005 and then increase to 0.033 in 2008 (Table H.4-12 of Appendix H). These values are below the $F_{35\%}$ level of 0.057 and the $F_{40\%}$ level of 0.048, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. The implied SPR fishing rates under FMP 1 is 51 percent in 2003, increasing to 56 percent in 2005, and decreasing to 51 percent in 2008. The average implied SPR rate of fishing from 2003-2008 is 51 percent. The impact of fishing mortality on BSAI Pacific ocean perch is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

Total biomass (ages 3 through 21+) 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 1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 396,000 mt in 2008, with a 2003-2008 average value of 385,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

Spawning biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 135,500 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 of Appendix H. Under FMP 1, model projections indicate that BSAI Pacific ocean perch biomass is expected to decrease to a value of 135,300 mt in 2004, then increase to a value of 138,800 mt in 2008, with a 2003-2008 average value of 136,800 mt. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

In recent years, the Pacific ocean perch directed fishery in the Aleutian Islands typically occurs in the month of July. Fishery observer data from 2000-2002 indicates that approximately 80 percent of the Pacific ocean perch in the BSAI are harvested during this month; there is no directed fishing for Pacific ocean perch in the EBS management area. Projected harvest under FMP 1 indicates that an average of 10,600 mt is harvested in the BSAI area, with 49 percent from the eastern Aleutians, 23 percent from the western Aleutians, 22 percent from the central Aleutians, and 6 percent from the EBS. This impact is expected to be insignificant, because the concentration of harvest under FMP 1 would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 1.Therefore, the effects of FMP 1 on habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Pacific Ocean Perch

Because BSAI Pacific ocean perch are fished at less than the OFL and are above the minimum stock size threshold, the direct and indirect effects under FMP 1 are considered insignificant. Fishing rates are well 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.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, 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 BSAI Pacific ocean perch are below the ABC and OFL levels in all years, 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 under FMP 1 (Table H.4-12 of Appendix H).

Age and Size Composition

Under FMP 1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections, is 10.38 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 1.

Cumulative Effects of FMP 1

Table 4.5-20 summarizes the cumulative effects analysis for BSAI Pacific ocean perch.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under FMP 1.

- **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 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.

<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 1.

- **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 change in biomass 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 is identified for the change in biomass and is rated 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 is 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 potentially beneficial or adverse contributor to reproductive success since changes in climate can affect prey availability and/or habitat suitability which in turn can affect 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.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** It is determined that FMP 1 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 potentially beneficial or adverse contributors. 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.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** It is determined that FMP 1 would have insignificant effects 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, 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 3.6.4 for additional information on the effects of trawling on benthic habitat). 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 potentially 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 BSAI Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

GOA Pacific Ocean Perch – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA Pacific ocean perch. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1. Section 3.5.1.24 discusses the past/present effects analysis for GOA Pacific ocean perch in more detail.

Total and Spawning Biomass and Fishing Mortality

ABC is used as a proxy for TAC in model projections. The FMP 1 model projections for GOA Pacific ocean perch catch are unrealistically low relative to projected ABC. For example, from 1997 to 2001 catch of Pacific ocean perch in the western, central, and eastern GOA has averaged 76 percent of the ABC (Heifetz *et al.* 2002). Average projected catch for the years 2003-2008 under FMP 1 is only 57 percent of projected ABC. Consequently, average catch under FMP 1 would likely be higher (average of 76 percent of projected ABC) for the years 2003-2008. Spawning biomass, fishing mortality, vulnerable biomass, and implied SPR rates would also change relative to an average catch of 76 percent of projected ABC for the years 2003-2008. However, average fishing mortality during the years 2003-2008 is still expected to be less than F_{OFL} (0.060) (Table H.4-36 of Appendix H). Because total and spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1. The impact of fishing mortality on GOA Pacific ocean perch is also expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Spatial/Temporal Concentration of Catch

Under FMP 1, trawl fishing is not permitted in the southeast/east Yakutat area and the ABC (approximately 12 percent of the total GOA ABC) normally allocated to that area is not likely to be caught. Under FMP 1, GOA Pacific ocean perch are taken in the central (80 percent of GOA Pacific ocean perch captured), western (13 percent), and eastern (7 percent) GOA, primarily in directed Pacific ocean perch bottom trawl fisheries (74 percent of GOA Pacific ocean perch captured), directed Pacific ocean perch pelagic trawl fisheries (11 percent), and as bycatch in directed bottom trawl fisheries for other rockfish species (11 percent).

Under FMP 1, the ABC for Pacific ocean perch is determined for the entire GOA, and then geographically apportioned among management areas. This apportionment spreads fishery effort over the GOA and reduces the risk of localized depletion. In the GOA, Pacific ocean perch are taken largely in directed fisheries and the fishery tends to concentrate in slope areas away from the proposed closures for Steller sea lion prey species under FMP 1.

Under FMP 1, the Pacific ocean perch trawl fishery would be managed as under the current GOA FMP which has an open season that occurs in July and generally lasts a few weeks. The open fishery system compresses the fishery effort into a short time period and creates difficulty for the management of the fishery by increasing the risk of possible overfishing if the fishery is not closed before catch exceeds ABC.

For the reasons discussed above, the impact of the spatial/temporal concentration of catch on GOA Pacific ocean perch is expected to be insignificant under FMP 1, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Under FMP 1, bottom trawling or other fishing gear in contact with the ocean floor of the GOA continental shelf and upper slope could adversely affect the habitat of juvenile Pacific ocean perch. Juvenile Pacific ocean perch tend to live inshore in shallower depths than adults, and may also be associated with epifauna that provides structural relief on the bottom such as corals or sponges. If so, damage to this epifauna by bottom trawls may reduce survival of juvenile fish.

At the same time, FMP 1 would reduce impacts to GOA Pacific ocean perch habitat because it would close the eastern GOA to trawling. This would create a *de facto* no-take zone or refugium for Pacific ocean perch in this area, as trawls are generally the only effective gear for capturing this species. Biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA contains 12 percent of the GOA biomass of Pacific ocean perch. Consequently, this refugium may be large enough to provide enhanced protection to the rockfish resource. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. The trawl closure would also prevent damage to the benthic environment in the eastern GOA, because bottom trawls would no longer be used. Although little is known about the habitat preferences of Pacific ocean perch, an undamaged benthic habitat likely provides a benefit to the adults as well as juveniles of this species.

On balance, FMP 1 would create conditions for both beneficial and adverse impacts on GOA Pacific ocean perch habitat. It is unlikely, however, that future levels of habitat disturbance under FMP 1 would lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

The major prey of Pacific ocean perch is euphausiids, and Pacific ocean perch may in turn be preyed upon by large piscivorous fish. There is no indication that existing trophic interactions would undergo significant qualitative change under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Pacific Ocean Perch

The analysis of potential direct and indirect effects on GOA Pacific ocean perch is based on stock sustainability as indexed by projection model estimates of fishing mortality relative to the overfishing limit (F_{OFL}), and by projection model estimates of female spawning stock biomass relative to the MSST.

Under FMP 1, 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 1, 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. The direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, and 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.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, GOA Pacific ocean perch projected female spawning biomass for 2003 (B2003) of 113,000 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. Projected female spawning biomass for 2005 (B2005) of 113,500 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition

GOA Pacific ocean perch are slow growing and long-lived (maximum age 84 years; mean age at recruitment, 10 years; Heifetz *et al.* 2002).

Under FMP 1, the age composition of GOA Pacific ocean perch could change under fishing pressure. For example, under FMP 1, the mean age of the GOA Pacific ocean perch in 2008, as computed in model projections, is 10.6 years. This compares with an estimated mean age in the equilibrium unfished GOA stock of 14.3 years. Note that the mean ages and sizes actually observed in 2008 will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of GOA Pacific ocean perch is 50:50, but females are generally larger than males. No information is available to suggest that sex ratio would change under FMP1, but size composition of GOA Pacific ocean perch might change in proportion to the change in age composition.

Cumulative Effects of FMP 1

Table 4.5-21 summarizes the cumulative effects analysis for GOA Pacific ocean perch.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under FMP 1.

- **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 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 Pacific ocean perch stock is expected to be insignificant under FMP 1.

- **Persistent Past Effects.** Past effects on the change in biomass level 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 level are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect for 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.** 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 change in genetic structure and reproductive success of GOA Pacific ocean perch are the same as those indicated for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in genetic structure and reproductive success of GOA Pacific ocean perch are the same as those indicated for BSAI Pacific ocean perch under this FMP.

- **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.** It is determined that FMP 1 would have an insignificant effect on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past effects on the change in prey availability 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 are the same as those described for BSAI Pacific ocean perch under this FMP.

- **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.** It is determined that FMP 1 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability 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 are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated 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.

4.5.1.12 Thornyhead Rockfish

Numerous fishery management actions have been implemented that affect the thornyhead rockfish fisheries in the GOA. These actions 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 by the National Standard Guidelines. 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 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA thornyhead rockfish. All of these potential effects are expected to be insignificant. The significance ratings are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

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 1, fishing mortality is projected to decrease to 0.021 in 2003 and decrease further to 0.016 in 2007. These values are well below the F_{MSY} proxy value of 0.102 which is the rate associated with the OFL (Table H.4-37 of Appendix H). The impact of fishing mortality on GOA thornyhead rockfish is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

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 1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly increase to a value of 56,000 mt by 2007, with a 2003-2007 average value of 55,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

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 of Appendix H. Under FMP 1, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and increasing to 24,600 mt by 2007, with a 2002-2007 average value of 24,100 mt. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

Thornyhead catch is approximately evenly divided between longliners and trawlers under status quo management. There is nothing about FMP 1 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 Individual Fishing Quota (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. 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. Therefore, this impact is expected to be insignificant, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Under FMP 1, all current management measures would be maintained. The level of habitat disturbance expected under FMP 1 would 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. There is no indication that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP. Therefore, the effects of FMP 1 on thornyhead habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

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 status quo federal groundfish fisheries 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. There is no indication that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Therefore, this impact is expected to be insignificant because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on 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 1, we do not expect any significant population effects to thornyheads.

Status Determination from Modeling

Stock Size Relative to MSST

The GOA thornyhead stock is not overfished. At 23,500 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) in the year 2002 and will remain above $B_{40\%}$ in all projection years under FMP 1.

Age and Size Composition

Under FMP 1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.23 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 1.

Cumulative Effects of FMP 1

Table 4.5-22 summarizes the cumulative effects analysis for GOA thornyhead rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under FMP 1.

- **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 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; 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.** It is not expected that FMP 1 will result in a significantly adverse impact to these stocks.

- **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 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potentially 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 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 potentially 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 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 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 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 potentially 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 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 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 potentially 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 3.6.4 for information on the impacts of fishery gear on EFH. 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.

4.5.1.13 Rockfish

At least 32 rockfish species of the genera *Sebastes* and *Sebastolobus* have been reported to occur in the GOA and BSAI (Eschmeyer *et al.* 1984), and several of these species are of commercial importance. Sections 3.5.1.12 and 3.5.1.24 describes rockfish in the BSAI and GOA in more detail.

BSAI Northern Rockfish – Direct/Indirect Effects of FMP 1

Until recently, northern rockfish, rougheye rockfish, and shortraker rockfish made up the other red rockfish assemblage in the BSAI. This group was managed under Tier 5 of Amendment 56 to the BSAI groundfish management plan. As of 2004, northern rockfish is managed separately under Tier 3, and shortraker/rougheye rockfish are managed under Tier 5. The other red rockfish group no longer exists. BSAI northern rockfish were modeled under the Tier 5 category for this analysis. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

<u>Fishing Mortality</u>

The catch of BSAI northern rockfish in 2003 was estimated as 6,400 mt. Projected catches from 2003-2008 are shown in Table H.4-15 in Appendix H. Under FMP 1, model projections indicate that the catch is expected to decrease to 5,400 mt in 2005, then increase to 5,600 mt in 2008. The 2003-2008 average catch is 5,800 mt. The impact of fishing mortality on BSAI northern rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Reliable estimates of total and spawning biomass are not available for this species. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

Northern rockfish are caught as bycatch in the BSAI area, with much of the harvest occurring in the Aleutian Islands (Spencer and Reuter 2002). Model projections indicate that the average harvest of 5,800 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (3,100 mt, 55 percent), with 1,260 mt (22 percent) occurring in the central Aleutians and 1,100 mt (18 percent) occurring in the western Aleutians. The harvest of northern rockfish in the Aleutian Islands is taken largely in the Atka mackerel fishery. The potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. There is no indication that existing habitat- mediated impacts would undergo significant qualitative change under FMP 1. Evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST. Therefore, the potential effect of FMP 1 on habitat suitability for BSAI northern rockfish is unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. There is no indication that trophic interactions would undergo significant qualitative change under FMP 1. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for BSAI northern rockfish is unknown.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Northern Rockfish

An age-structured population model for BSAI northern rockfish is not available, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI northern rockfish are fished at less than the OFL and the effects of mortality under FMP are considered insignificant. Since the MSST cannot be calculated, the spatial/temporal distribution of catch and other direct/indirect effects are unknown.

Status Determination from Modeling

Stock Size Relative to MSST

The catch rates are below the ABC and OFL values for all years. The MSST has not been determined for this species.

Age and Size Composition

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

Sex Ratio

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 1.

Cumulative Effects of FMP 1

Table 4.5-23 summarizes the cumulative effects analysis for BSAI northern rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under FMP 1.

- **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 3.5.1.12 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; 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 1, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not able to 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 3.5.1.12 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potentially 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 3.5.1.12 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 1 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 3.5.1.12 and Section 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potentially 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.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, 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 potentially beneficial or adverse effect. See Sections 3.5.1.12 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potentially 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 3.5.1.12 for more information on the trophic interactions of BSAI northern rockfish species.

- **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 1, 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 potentially 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 3.5.1.12 for more information on the past events that have affected northern rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potentially 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 1

As stated above, until recently, rougheye and shortraker rockfish made up the other red rockfish assemblage in the BSAI. These species now make up their own group and are managed under Tier 5. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The catch of BSAI shortraker/rougheye rockfish in 2003 was estimated as 800 mt. Projected catches from 2003-2008 are shown in Table H.4-16 in Appendix H. Under FMP 1, model projections indicate that the catch is expected to range between 700 and 900 mt between 2003 and 2008, with an average catch of 800 mt. The impact of fishing mortality on BSAI shortraker/rougheye rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Reliable estimates of total and spawning biomass are not available for these stocks. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

Shortraker/rougheye rockfish are caught as bycatch in the BSAI area, with much of the harvest occurring in the Aleutian Islands (Spencer and Reuter 2002). Model projections indicate that the average harvest of 800 mt from 2003-2008 occurs evenly throughout the Aleutians Islands, with between 27 percent-31 percent occurring in each of the Aleutian Islands subareas. The harvest of shortraker/rougheye rockfish in the Aleutian Islands is taken in the Pacific ocean perch and Pacific cod longline fisheries. The potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. There is no indication that existing habitat- mediated impacts would undergo significant qualitative change under FMP 1. Evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST. Therefore, the potential effect of FMP 1 on habitat suitability for BSAI shortraker/rougheye rockfish is unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. There is no indication that trophic interactions would undergo significant qualitative change under FMP 1. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for BSAI shortraker/rougheye rockfish is unknown.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Shortraker/Rougheye Rockfish

An age-structured population model is not available for either BSAI shortraker or rougheye rockfish, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI shortraker/rougheye rockfish are fished at less than the OFL and the effects of mortality under FMP 1 are considered insignificant. Since the MSST cannot be calculated, the spatial/temporal distribution of catch and other direct/indirect effects are unknown.

Status Determination from Modeling

Stock Size Relative to MSST

The catch rates are below the ABC and OFL values for all years. MSSTs have not been determined for these stocks.

Age and Size Composition

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

Sex Ratio

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 1.

Cumulative Effects of FMP 1

Table 4.5-24 summarizes the cumulative effects analysis for BSAI shortraker/rougheye rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under FMP 1.
- **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 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 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 1, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not able to 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 an adverse persistent past effect on BSAI shortraker/rougheye rockfish. See Section 3.5.1.13 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potentially 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 1 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 Section 3.5.1.13 and Section 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shortraker/rougheye rockfish due to climate changes and regime shifts are potentially 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, but the effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, 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 potentially beneficial or adverse effect. See Sections 3.5.1.13 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potentially 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 one of the main prey species of rougheye rockfish. See Section 3.5.1.13 for more information on the trophic interactions of BSAI shortraker/rougheye rockfish species.

- **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 1, 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 potentially 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 for more information on the past events that have affected shortraker/rougheye rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potentially 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 1

Twenty-nine species are included in the BSAI other rockfish assemblage (see Section 3.5.1.14), but they are dominated in abundance by the light dusky rockfish and shortspine thornyheads. Currently, this complex is assumed to be two separate stocks in the EBS and Aleutian Islands regions and is assessed as such. The BSAI other rockfish assemblage falls under Tier 5 of Amendment 56 of the BSAI groundfish FMP, relying on biomass estimates to determine ABC and OFL values. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The catch of Aleutian Islands other rockfish in 2003 was estimated as 300 mt, ranging between 200 mt and 300 mt from 2003 to 2008. In the EBS, the projected harvest was 100 mt in each projection year. Projected catches from 2003-2008 are shown in Tables H.4-13 and H.4-14 in 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 is well below the OFL for other rockfish, so FMP 1 is not likely to jeopardize the capacity of the stock to produce MSY on a continuing basis. Therefore, this impact is considered insignificant.

When species are managed as complexes rather than individual species, more abundant species may be disproportionately exploited and thus suffer higher mortality. For example, Reuter and Spencer (2002) recommended that light dusky rockfish be split out of the other rockfish group and assigned a separate ABC. Their findings indicate that light dusky rockfish make up a large amount of the other rockfish catch in the Aleutian Islands and may be disproportionally exploited. Furthermore, Reuter and Spencer (2002) have recommended that EBS and Aleutian Islands biomass estimate for light dusky rockfish be combined for the BSAI. This recommendation comes in light of new catch and survey distribution maps which show continuous spatial distribution of light dusky rockfish along the Aleutian Islands and EBS slope.

Change in Biomass Level

Estimates of total and spawning biomass are not available for these species. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

Species included in the other rockfish category are caught as bycatch in the BSAI area, with much of the harvest occurring in the Aleutian Islands (Reuter and Spencer 2002). In the Aleutian Islands, 89 percent of the average harvest of 300 mt occurs largely in the western and central Aleutian Islands, taken largely in the Atka mackerel trawl fishery and the sablefish longline fishery. In the EBS, the average catch of 100 mt is taken largely in the Pacific cod bottom trawl fishery, and the sablefish and Greenland turbot longline fisheries. Information is insufficient to determine whether existing harvest patterns would undergo any significant change under FMP 1. Consequently, the potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST.

Habitat Suitability

Any habitat suitability impacts of FMP 1, such as adverse effects to spawning habitat, nursery grounds, and benthic structures, as a result of commercial fishing would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST. Therefore, the potential effect of FMP 1 on habitat suitability for BSAI shortraker/rougheye rockfish is unknown.

Prey Availability

As with habitat related impacts, any effects of FMP 1 on predator-prey relationships would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that such trophic interactions would undergo any significant change from the current condition. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for BSAI shortraker/rougheye rockfish is unknown.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Other Rockfish

An age-structured population model is not available for either Aleutian Islands or EBS other rockfish, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, other rockfish are fished at less than the ABC in each area, and the direct and indirect effects under FMP 1 are considered either insignificant or unknown. The spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

Status Determination from Modeling

Stock Size Relative to MSST

The F is below the ABC and OFL values for the other rockfish complex. MSSTs have not been determined for these species.

Age and Size Composition

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

Sex Ratio

The estimated sex ratio is not available for these species.

Cumulative Effects of FMP 1

Table 4.5-25 summarizes the cumulative effects analysis for BSAI other rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described 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 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 1, the effect of changes in biomass level is rated as unknown since the MSST for this stock complex is not able to be determined.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those described 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 1 the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine.

- **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 described for shortraker/rougheye rockfish under this FMP.

- **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 1, 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 of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **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 1, 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 of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **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 other rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

GOA Northern Rockfish – Direct/Indirect Effects of FMP 1

Tier 3a is used to compute the ABC and OFL values for northern rockfish. Northern rockfish are combined with other slope rockfish in the eastern GOA (Heifetz *et al.* 2002). The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA northern rockfish. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality and Change in Biomass Level

Average projected catch under FMP 1 is only 49 percent of projected ABC during the years 2003 to 2008. Consequently, average catch under FMP 1 would likely be higher (average catch of 71 percent of projected ABC) during the years 2003 - 2008. Spawning biomass, fishing mortality, vulnerable biomass, and implied SPR rates would also change relative to an average catch of 71 percent of ABC during the years 2003 to 2008. However, average fishing mortality during the years 2003 to 2008 is still expected to be less than F_{OFL} (0.066). A lack of recent strong year-classes to the age structured model for GOA northern rockfish also leads to the projected ABC and catch decreasing with time, which is adequately represented in the projection model (Table H.4-35 of Appendix H). The impact of fishing mortality on GOA northern rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The potential impact of FMP 1 on GOA northern biomass levels is also expected to be insignificant, because total and spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

Under FMP 1, GOA northern rockfish are taken in the central (89 percent of GOA northern rockfish captured) and the western (11 percent) GOA, primarily in directed rockfish bottom trawl fisheries (60 percent of GOA northern rockfish captured) and as bycatch in Pacific ocean perch bottom trawl fisheries (22 percent).

The ABC for northern rockfish is determined for the entire GOA and then geographically apportioned among management areas. This apportionment spreads fishery effort over the GOA in an effort to reduce the risk of localized depletion. However, the majority of EBS and GOA northern rockfish commercial catches have historically come from the same localized geographic regions year after year. The largest GOA commercial catches occurred in one area known as the Snakehead which accounted for 45.8 percent of all GOA northern rockfish catches from 1990-1998 (Clausen and Heifetz, in preparation). Similarly, the largest EBS commercial catches occurred in one area known as the Zhemchug Canyon which accounted for 57.05 percent of all EBS northern rockfish catches from 1990-1998 (Clausen and Heifetz, in preparation). Aleutian Islands northern rockfish commercial catches were also concentrated in several geographic regions, but there was no single localized aggregation that dominated the catch year after year. Based upon these highly localized catches, northern rockfish are not believed to be highly mobile or migratory as adults and there may be a potential for localized depletion of this stock even with apportionment among management areas.

Northern rockfish catches in the GOA are largely taken in directed rockfish fisheries and are highly localized in areas away from the proposed Steller sea lion prey species closures found in FMP 1.

Under FMP 1, the northern rockfish trawl fishery would be managed as under the current GOA FMP which has an open season that occurs in July and generally lasts a few weeks. The open fishery system compresses the fishery effort into a short time period and creates difficulty for the management of the fishery by increasing the risk of possible overfishing if the fishery is not closed before catch exceeds ABC.

This impact is expected to be insignificant; the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Under FMP 1, bottom trawling or other fishing gear in contact with the ocean floor on the GOA 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 to 175 m. 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.

FMP 1 closes the eastern GOA to trawling. However, the eastern GOA contains less than one percent of the GOA biomass of northern rockfish (Heifetz *et al.* 2002). Consequently, this closure probably has little effect on the GOA stock of northern rockfish.

The effects of FMP 1 on habitat suitability for GOA northern rockfish are expected to be insignificant because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

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 no indication that existing trophic interactions would undergo significant qualitative change under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Northern Rockfish

The comparative baseline for effects on GOA northern rockfish is the impact on stock sustainability as indexed by projection model estimates of fishing mortality relative to overfishing limits (F_{OFL}) and by projection model estimates of female spawning stock biomass relative to the MSST.

Under FMP 1, 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 1, 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.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, GOA northern rockfish projected female spawning biomass for 2003 (B2003) of 42,700 mt is greater than $B_{35\%}$. Thus, the stock is projected to be above its MSST and is not projected to be in an overfished condition. Projected female spawning biomass for 2005 (B2005) of 39,100 mt is greater than $B_{35\%}$; consequently, the stock is not projected to be approaching an overfished condition.

Age and Size Composition

Under FMP 1, the age composition of GOA northern rockfish could change under fishing pressure. For example, under FMP 1 the mean age of the GOA northern rockfish in 2008, as computed in model projections, is 11.2 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.6 years. Note that the mean ages and sizes actually observed in 2008 will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of GOA northern rockfish is 50:50. No information is available to suggest that sex ratio would change under FMP 1, but size composition of GOA northern rockfish might change in proportion to the change in age composition.

Cumulative Effects of FMP 1

Table 4.5-26 summarizes the cumulative effects analysis for GOA northern rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under FMP 1.

- **Persistent Past Effects.** Past effects of the foreign fisheries for the GOA northern rockfish stock. Include large removals, which appear to have a lingering effect on the 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 in 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 under FMP 1 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 1.

- **Persistent Past Effects.** Past effects of the foreign fisheries for the GOA northern rockfish stock. Include large removals, which appear to have a lingering effect on the 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 in 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.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass and is rated 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.

Spatial/Temporal Concentration of Catch

– 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 in 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 potentially beneficial or adverse contributors to reproductive success since changes in climate can affect prey availability and/or habitat suitability which in turn can affect 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 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.** It is determined that FMP 1 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 benficial 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 potentially 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.** It is determined that FMP 1 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 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 3.6.4 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 stated 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 potentially beneficial or adverse contributors, although the magnitude and direction of the change are unknown in relation to strong and weak Aleutian Low systems. 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 1

Shortraker/rougheye and other slope rockfish groups are placed in Tier 4 and 5. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA shortraker/rougheye rockfish. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The model projections for catch of shortraker/rougheye show relatively constant catches of about 1,000 mt over the years 2003-2007 (Table H.4-34 of Appendix H). These projected catches are less than would be expected if the present management policies were to remain in place, which this FMP assumes. ABC for shortraker/rougheye in the model (1,600 mt) is virtually the same as that for the fishery in the years 1997-2002 (ABCs of 1,590-1,730 mt, depending on the year), but catches in the fishery have averaged 1,602 mt over this period versus the 1,000 mt projected in the model. The reason for the lower-than-expected catch projections in the model for this FMP is uncertain. The impact of fishing mortality on GOA shortraker/rougheye rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

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. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

The ABCs are geographically apportioned amongst the major management areas of the GOA which helps to spread out the catch and reduces the risk of localized depletion of the resource. Recent genetic studies of shortraker and rougheye rockfish indicate that there is stock structure for each species in the GOA, but additional research is needed for further verification and to better define the geographic extent of this structure. Until more information is available on this possible stock structure, there is a possibility that localized depletion may be occurring, despite the effort of geographic apportionment.

Shortraker/rougheye are to be taken only as bycatch in the GOA. The bycatch of these two species is taken in both bottom trawl and longline fisheries; the annual proportion caught by bottom trawl is usually a little higher than that caught by longline. The sablefish and halibut longline fisheries, in which shortraker/rougheye are taken as bycatch, have been IFQ fisheries since 1995. As a result, these two fisheries have been open concurrently between March 15 and November 15 each year, which spreads out the catch of shortraker/rougheye over this entire eight month period. In contrast, bottom trawl fisheries that catch shortraker/rougheye are much shorter in duration, and are usually open for only a few weeks per year. This compresses the shortraker/rougheye trawl catch into a relatively short time period and may cause a greater risk of possible overfishing, because it is difficult to manage the TAC within this short time span.

The potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST.

Habitat Suitability

This FMP may beneficially affect 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 2002). 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. However, evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST. Therefore, the potential effect of FMP 1 on habitat suitability for shortraker/rougheye is unknown.

Prey Availability

The major prey of adult rougheye rockfish in Alaska appears to be shrimp (Yang 1993 and 1996; Yang and Nelson 2000). Food habit information for shortraker rockfish is very limited, but the sparse data available at present indicate that squid, myctophids, and shrimp are the major items consumed (Yang 1993 and 1996; Yang and Nelson 2000). Pacific cod, and to a lesser extent walleye pollock, are also species that are known to prey on shrimp, so any changes in their abundance as a result of FMP 1 hypothetically could affect the food supply of shortraker/rougheye. To protect Steller sea lions, FMP 1 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.

There is no documentation of predation on either shortraker or rougheye rockfish. Consequently, it is not possible to determine how changes in predator abundance as a result of FMP 1 would affect these rockfish. Presumably, larger fishes such as Pacific halibut that are known to prey on other rockfish may also prey on rougheye rockfish, but adult shortraker rockfish are so large that they probably have few predators. Predator effects would likely be more important on juveniles of either species.

Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for shortraker/rougheye is unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Shortraker/Rougheye Rockfish

The effects of FMP 1 on shortraker/rougheye in the GOA are summarized in Table 4.5-83. The effect of FMP 1 on these species through direct mortality from fishing is expected to be insignificant. All other potential direct and indirect effects of FMP 1 on this group are unknown.

Status Determination from Modeling

Stock Size Relative to MSST

The catch rates are below the ABC and OFL values for all years. The MSST has not been determined.

Age and Size Composition

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.

Sex Ratio

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 1 is unknown.

Cumulative Effects of FMP 1

Table 4.5-27 summarizes the cumulative effects analysis for GOA shortraker/rougheye rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under FMP 1.

- **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 an adverse persistent past effect on GOA shortraker/rougheye rockfish stocks. See Section 3.5.1.24 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 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

  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 1, the effect of changes in biomass level is unknown since the MSST for this stock is not able to 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 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass 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 potentially 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 1 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 potentially 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 for more information.

- **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, they 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 1 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 for more information.

- **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 potentially beneficial or adverse contributors to prey availability. See Sections 3.5.1.24 and 3.10 for more information. 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.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 1.

- **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 for more information.

- **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 potentially beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. 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 3.6.4 for more information on the impacts of fishery gear on EFH.

- **Cumulative Effect.** 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 1

Other slope rockfish groups are placed in Tier 5 where ABC is determined by F = 0.75M. Sharpchin rockfish are assessed under Tier 4 where OFL is calculated by F = M. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

A measure in this FMP that has a major influence on protecting slope rockfish species from over-harvest is the fact that under FMP 1, the eastern GOA is closed to all trawling. Trawl surveys show the biomass for all species of slope rockfish in the GOA is concentrated in the eastern GOA (Heifetz *et al.* 2002). Because most species of slope rockfish are only taken in trawls and not caught in other gear types such as longlines or traps, the eastern GOA trawl closure creates a *de facto* refugium in which most of the GOA population of slope rockfish is protected from any fishing pressure.

The model projections for catch of slope rockfish show relatively constant catches of about 700 mt in the years 2003-2007. These catches are similar to those seen in recent past years, so the projections for catch appear to be reasonable (Table H.4-31 of Appendix H). The impact of fishing mortality on GOA slope rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

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 total or spawning biomass or the MSST. Therefore, the potential impact of FMP 1 on biomass level is unknown.

Spatial/Temporal Concentration of Catch

The ABCs are geographically apportioned amongst the major management areas of the GOA which helps to spread out the catch over the GOA and reduces the risk of localized depletion of the resource. 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 1 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, rockfish trawl fisheries in the GOA in past years have only been open for a few weeks in July. This greatly compresses the catch into a short time period and has caused a greater risk of possibly overfishing slope rockfish, because it is difficult to manage the fishery within this short time span.

The potential impact of FMP 1 on GOA slope rockfish is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST (which has not been determined for these stocks).

Habitat Suitability

This FMP 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. As noted above, nearly all the biomass of slope rockfish is found in the eastern GOA, which means the trawl closure in this region protects most of the GOA population from any fishing pressure. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most rockfish are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. The trawl closure also 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 slope rockfish, an undamaged benthic habitat likely provides a benefit to these species. Juvenile slope rockfish may also be associated with epifauna such as corals or sponges that provide structural relief on the bottom. Prevention of possible damage by bottom trawls to corals and other "living substrates" may increase the amount of protective cover available to slope rockfish to escape predation, increase survival of juvenile fish and thus have a beneficial impact on the stocks. On balance, however, evidence is insufficient to conclude whether, or to what extent, future levels of habitat protection would lead to a change in spawning or rearing success that would measurably affect the ability of the GOA slope rockfish stock to sustain itself at or above the MSST (which has not been determined for these stocks). Therefore, the potential effect of FMP 1 on habitat suitability for this group must be considered unknown.

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, which are known to prey on other rockfish, presumably also prey on slope rockfish. Because of this lack of information, the effect of FMP 1 on predator-prey relationships for slope rockfish is unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Slope Rockfish

The effects of FMP 1 on GOA slope rockfish are summarized in Table 4.5-83. The effect of FMP 1 on these species through direct mortality from fishing is expected to be insignificant. All other potential direct and indirect effects of FMP 1 on this group are unknown.

Status Determination from Modeling

No projections are possible for the F 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

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

Sex Ratio

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 1 is unknown.

Cumulative Effects of FMP 1

Table 4.5-28 summarizes the cumulative effects analysis for GOA other slope rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under FMP 1.

- **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 an adverse persistent past effect on GOA other slope rockfish stocks. See Section 3.5.1.24 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 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 are identified as a non-contributing factor since catch and bycatch of slope rockfish species are 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 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 1, the effect of changes in biomass level is unknown since the MSST for this stock is not able to 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 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass 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 potentially 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. 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 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 1 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 potentially beneficial or adverse effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability, which in combination affect reproductive success. See Sections 3.5.1.24 and 3.10 for more information.

- **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 and 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 occur 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.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 1 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 for more information.

- **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 potentially beneficial or adverse contributors to prey availability. See Sections 3.5.1.24 and 3.10 for more information. 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.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 1.

- **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 for more information.

- **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 potentially beneficial or adverse contribution to slope rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. 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 3.6.4 for more information on the impacts of fishery gear on EFH.

- **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.

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of FMP 1

Until recently, dusky rockfish fell under Tier 4 of Amendment 56 of the GOA groundfish FMP, while yellowtail and widow rockfish are managed under Tier 5. As of 2004, dusky rockfish will be managed as a Tier 3 species, while the remaining pelagic shelf rockfish (PSR) species will continue under Tier 5. GOA dusky rockfish were modeled under the Tier 4 category for this analysis. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

<u>Fishing Mortality</u>

The model projections for catch of PSR show a progressive decline from 3,300 mt in the baseline year of 2002 to a minimum of 2,000 mt in 2005, and only a slight increase to 2,100 mt in 2006 and 2007. These projected catches are less than would be expected if the present management regime were to remain in place, which this FMP assumes. ABC for the projections remains a constant 5,500 mt for each year, which means less than40 percent of the ABC would be taken in each of the years 2005-2007. In most years before present, at least 60 percent of the ABC for PSR has been caught. The reasons for the lower-than-expected catch projections in the model for this FMP are uncertain (Table H.4-32 for Appendix H). The impact of fishing mortality on this group is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Total and Spawning Biomass</u>

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. Therefore, the potential impact of FMP 1 on biomass level is unknown, because biomass levels and MSSTs have not been determined.

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

The ABCs are geographically apportioned amongst the major management areas of the GOA which helps to spread out the fishery over the GOA and reduces the risk of localized depletion of the resource. However, there have been no studies to determine stock structure of dusky rockfish, and it is unknown if subpopulations exist. Because there is no information on stock structure, there is a possibility that localized depletion may be occurring, despite the effort of geographic apportionment.

In FMP 1, there is no system for IFQs or cooperatives for rockfish trawlers, who take nearly all the catch of PSR. As a result, the PSR trawl fishery in past years has only been open for a few weeks in July. This greatly compresses the catch into a short time period and has caused a greater risk of possible overfishing, because it is difficult to manage the fishery within this short time span. The potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect this group's ability to sustain itself at or above the MSST, and MSSTs have not been established for these stocks.

Habitat Suitability

This FMP would affect 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 GOA biomass of dusky biomass, this is still large enough that it may provide enhanced protection to the dusky rockfish resource. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. The trawl closure also prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. On balance, however, evidence is insufficient to conclude whether, or to what extent, future levels of habitat protection would lead to a change in spawning or rearing success that would measurably affect the ability of the GOA slope rockfish stock to sustain itself at or above the MSST (which has not been determined for these stocks). Therefore, the potential effect of FMP 1 on habitat suitability for this group must be considered unknown.

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 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 as food to dusky rockfish. To protect Steller sea lions, FMP 1 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. How adverse this effect would really be, however, is unknown, as 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.

There is no documentation of predation on dusky rockfish. Consequently, it is not possible to determine how changes in predator abundance as a result of FMP 1 would affect dusky rockfish. Presumably, larger fishes such as Pacific halibut that are known to prey on other rockfish may also prey on adult dusky rockfish, but it unknown what impact this predation has on stock condition. Predator effects would likely be more important on juvenile dusky rockfish. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for PSR is unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Pelagic Shelf Rockfish

The effects of FMP 1 on GOA slope rockfish are summarized in Table 4.5-83. The effect of FMP 1 on these species through direct mortality from fishing is expected to be insignificant. All other potential direct and indirect effects of FMP 1 on this group are unknown.

Status Determination from Modeling

The catch rates are below the ABC and OFL values. The MSST cannot be determined for this stock complex.

Age and Size Composition

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.

Sex Ratio

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 1 is unknown.

Cumulative Effects of FMP 1

Table 4.5-29 summarizes the cumulative effects analysis for GOA pelagic slope rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA PSR complex is insignificant under FMP 1.

- **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 for more information.

- **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 levels 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 1 on the change in 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 demersal shelf rockfish (DSR) population. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp 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 Bs 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 fishery on the spatial/temporal characteristics of PSR under FMP 1 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 potentially beneficial or adverse effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination affect reproductive success. See Sections 3.5.1.24 and 3.10 for more information.

- **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, they could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** Although a cumulative effect of the spatial/temporal characteristics of the GOA PSR complex is possible, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fishery on the change in prey availability of PSR is 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 for more information.

- **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 potentially beneficial or adverse contributors to prey availability. See Sections 3.5.1.24 and 3.10 for more information.

- **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 fishery on the change in habitat suitability of PSR is 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 for more information.

- **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 for more information on the effects of fishery gear on EFH. 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 potentially beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

- **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 1

The DSR rockfish complex comprises seven species of nearshore, bottom-dwelling rockfishes (see Section 3.5.1.24). In the eastern GOA this group of rockfishes is subject of a directed longline fishery and consequently the NPFMC manages these species separately from the other rockfish category in the eastern GOA. For purposes of this Programmatic SEIS, emphasis is placed on yelloweye rockfish as it is the predominant species in the DSR assemblage and in the fishery. DSR fall into Tier 4 of the ABC and OFL definitions. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

DSR are taken in a small directed fishery with hook and line gear and as bycatch in the halibut longline fishery. Reported catch of DSR has been relatively constant over the last five years with landings ranging from 226 mt to 363 mt in large part due to very conservative management practices. Estimated bycatch mortality of DSR in the halibut fishery has ranged about 130 mt to 355 mt annually. A DSR bycatch limit is established during the halibut season to limit mortality of DSR in this fishery. The NPFMC has also recently approved a management measure that requires full retention of DSR species. Once approved by NOAA Fisheries, the measure will improve catch statistics and reduce discards and waste. These factors, and the recognized uncertainty in estimating DSR biomass in the eastern GOA, has led managers to set a conservative TAC of 390 mt for 2003 (O'Connell *et al.* 2002). The OFL for DSR is 540 mt (Table H.4-33 for Appendix H).

Under FMP 1, we expect both the TAC and reported landings to remain stable at present levels. Status quo policies are likely to have no significant impact on the ability of DSR to sustain current population levels. Fishing mortality will remain below the OFL. The impact of fishing mortality on these stocks is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Reliable total and spawning biomass statistics are not available for DSR species. Therefore, the potential impact of FMP 1 on biomass level is unknown, because biomass levels and MSSTs have not been determined.

Spatial/Temporal Concentration of Catch

Although management of this assemblage has been conservative, and overall the population appears stable, a decline in the density estimates in the Fairweather Grounds may be an indication that localized overfishing is occurring (O'Connell *et al.* 2002). The TAC for the eastern GOA is partitioned by management district based on biomass density and known habitat. The current harvest strategy indicates that two percent of the exploitable biomass is taken per year and that this level of exploitation is sustainable. However, fishing effort on the Fairweather Grounds appears to be concentrated in areas of best habitat and highest density and it may be that local overfishing occurs. If occurring, such localized overfishing could have a long-term adverse effect on DSR stocks due to their longevity and slow growth rate (O'Connell *et al.* 2002). Rockfish stocks typically require long periods to recover from high fishing pressure. We are unable to conclusively determine the effects of the fisheries on the spatial/temporal characteristics of GOA demersal rockfish species at this time.

Habitat Suitability

Any habitat suitability impacts of FMP 1, as illustrated through the GOA groundfish FMP, would be governed by a complex web of direct and indirect interactions which are difficult to quantify. These type of impacts would include adverse effects to spawning habitat, nursery grounds, and benthic structures, as a result of commercial fishing. Unfortunately, scientific information is insufficient at the present time to conclude whether existing habitat suitability indexes would undergo any significant change under the current FMP. Therefore, the effects of FMP 1 on habitat suitability are unknown.

Prey Availability

As with habitat suitability impacts, any effects to predator-prey relationships resulting from FMP 1 management would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for this species or group is unknown.

Summary of Effects of FMP 1 – GOA Demersal Shelf Rockfish

An age-structured population model for DSR rockfish is not used as we believe the current assessment more accurately reflects present biomass. Projections of future catch ABC and OFL levels were made by carrying forward the 2002 baseline values into the future. Under these assumptions, DSR rockfish stocks remain stable and are fished at less than the ABC in the eastern GOA, and the direct and indirect effects under FMP 1 are considered insignificant or unknown. Additional information is needed to determine whether current abundance levels are truly sustainable over the long-term, including improved time series of catch (and bycatch) by species, and age and size composition data of bycatch. Better estimates of important life history parameters and maturity schedules are also required. Improved survey techniques are needed to more accurately assess the DSR assemblage as well as more knowledge about the variety and location of complex rocky habitats in the eastern GOA.

Status Determination from Modeling

The MSST has not been determined for this stock complex.

Age and Size Composition

Age and size composition data are not available for GOA DSR species.

Sex Ratio

The sex ratio of GOA DSR species is unknown.

Cumulative Effects of FMP 1

Table 4.5-30 summarizes the cumulative effects analysis for GOA demersal slope rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is insignificant under FMP 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 for more information.

- **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 and bycatch in these fisheries are 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 cumulative effect is identified for mortality of GOA DSR and is rated as insignificant. DSR are expected to be fished at levels 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 effect of the fishery on the change in biomass under FMP 1 is 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 for more information.

- **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 and bycatch in these fisheries are 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 cumulative effect is identified for change in biomass; however, the effect is unknown since total and Bs are currently unavailable.

Spatial/Temporal Concentration of Catch
- 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 is unknown.

- **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 potentially 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 for more information.

- **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 and bycatch of these fisheries are already accounted for by the domestic groundfish management or bycatch 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, they could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** Although a cumulative effect on the spatial/temporal characteristics of the GOA DSR complex is possible, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability under FMP 1 is 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 for more information.

- **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 potentially beneficial or adverse contributors to prey availability. See Sections 3.5.1.24 and 3.10 for more information.

- **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.** Scientific information is insufficient at the present time to conclude whether existing habitat suitability indexes would undergo any significant change under the current FMP.

- **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 for more information.

- **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 for more information on the effects of fishery gear on EFH. 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 potentially beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA DSR, the effect is currently unknown due to lack of scientific information.

4.5.2 Prohibited Species Alternative 1 Analysis

Throughout these analyses, the prohibited species category is discussed separately from the non-target groundfish species groups since their management strategies are implemented by various agencies outside of NOAA Fisheries. Retention of prohibited species is forbidden in the BSAI and GOA groundfish fisheries. The prohibited species include:

- Pacific halibut (*Hippoglossus stenolepis*).

- Pacific salmon and steelhead trout (*Oncorhynchus mykiss*).

- Pacific herring (*Clupea pallasi*).

- Red king crab (*Paralithodes camtschaticus*), blue king crab (*P. Platypus*), golden or brown king crab (*Lithodes aequispinus*), bairdi Tanner crabs (*Chionoecetes bairdi*), and opilio Tanner crabs *(C. opilio*).

4.5.2.1 Pacific Halibut

Pacific halibut are managed by the 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.

Under the present groundfish FMPs, halibut bycatch mortality in the Alaska groundfish fisheries is limited by NOAA Fisheries to approximately 4,500 mt in the BSAI and 2,300 mt in the GOA, for a total of 6,800 mt. Total removals from both areas in 2002 were limited by IPHC to a conservative target of 48,800 mt (Clark and Hare 2003). This was achieved by limiting the directed commercial fishery to a catch of 37,100 mt, which allowed for the expected total of 11,700 mt in sport catch, bycatch, and subsistence.

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 and bycatch, 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 1. No evidence of fishery impacts to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 1 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 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 to be 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 1.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 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 1.

- **Persistent Past Effects.** No persistent past effects have been identified on changes in reproductive success of Pacific halibut. 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 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 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 1.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Halibut are opportunistic predators with a wide range of prey species. 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 1.

4.5.2.2 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.

Most Alaska salmon fisheries are stable with bycatch representing a very small proportion of the directed fisheries catch. Pollock fisheries account for approximately 90 percent of the salmon bycatch in the BSAI. However, the western Alaska chinook and chum salmon stocks are currently considered depressed. Stock composition of BSAI groundfish fisheries bycatch shows that approximately 58-70 percent of chinook bycatch and 19 percent of chum bycatch may originate in western Alaska stocks. Many western Alaska rivers from Bristol Bay to Kotzebue are major producers of chinook or chum salmon. Although these species occur in a large number of drainages throughout the region, the largest runs exist in the Nushagak, Kuskokwim, and Yukon Rivers. Throughout the region these species are subject to intense subsistence and commercial fisheries. These runs have been poor since 1998 when the Arctic-Yukon-Kuskokwim (AYK) region was declared an economic disaster area. In 2001, the Alaska Board of Fisheries designated many AYK chinook and chum salmon stocks as Stocks of Concern under the State of Alaska's Policy for the Management of Sustainable Salmon Fisheries. Among the stocks designated were Kuskokwim River chinook and chum salmon, Yukon River chinook and chum salmon, and Norton Sound chum salmon.

Annual commercial and subsistence harvest of chinook and chum salmon for Bristol Bay and AYK combined averaged approximately 300,000 chinook salmon and 1,100,000 chum salmon from 1998 through 2000 (Burkey *et al.* 2001, Vania *et al.* 2002, Weiland *et al.* 2001, Brennan *et al.* 2002). Year 2000 was particularly poor for both chinook and chum salmon throughout the region. Total chinook catch for the region was approximately 190,000 fish, down from almost 400,000 fish in 1998. Total chum salmon catch for the region was approximately 640,000 fish, down from about one million in the previous two years, which were considered depressed as well. These poor runs resulted in extensive commercial closures for chinook and chum and subsistence closures for chum salmon in the AYK region since 1998.

Of the Northwest salmon species listed as endangered or threatened under the ESA, chinook and steelhead stocks are thought to migrate into areas managed by BSAI and GOA groundfish FMPs. Steelhead trout have not been observed in BSAI or GOA groundfish fisheries salmon bycatch. Bycatch of chinook salmon originating in the Northwest may occur in groundfish fisheries; however, ADF&G intensely manages this stock to ensure that bycatch does not exceed limits set forth by the ESA. Thus, ESA-listed Pacific Northwest chinook salmon and steelhead trout were not specifically considered in this cumulative effects analysis.

Of the 407 chinook stocks harvested in the regioneast, 81 percent are classified as not threatened, and 15 percent are special concern or at risk (Slaney *et al.* 1996). Large portions of the regioneast chinook harvest originate from the Columbia River upriver bright chinook, Middle Columbia River bright chinook, and north-migrating Oregon coastal chinook; these stocks are considered stable (NMFS 2002). Chinook stocks listed under the ESA make up a small portion of the regioneast harvest, and nearly all coho salmon harvested originate from Alaskan streams (Weitkamp *et al.* 1995).

Management of Alaskan salmon stocks is challenging due to the lack of precise information on total return and the inability to predict future returns to most rivers or tributaries with any degree of certainty. In most cases, total return and escapement are not known. As a result of this lack of information, estimates of significant impacts of bycatch on various runs are unreliable. Another factor to consider in salmon management is the Alaska subsistence preference law cite. This law requires that commercial, recreational, and personal use fisheries be restricted before restriction of subsistence fisheries. Therefore, management of all fisheries for these stocks in state waters incorporates conservative measures.

For analysis of the impacts of the FMPs presented here, the following assumptions have been made:

- 96 percent of "other salmon" caught in the BSAI are chum salmon (taken from observer data 1997-1999).

- BSAI chinook and other salmon bycatch is comprised of 58 to 70 percent of western Alaska chinook, and 19 percent of western Alaska chum salmon. Western runs occur in Bristol Bay, Kuskokwim, Nushagak, Yukon, Norton Sound, and Kotzebue regions. Runs in this region are considered depressed, due to severely poor runs in the Yukon and Kuskokwim River drainages in recent years.

- GOA chinook and other salmon bycatch is comprised of approximately 58 percent of western Alaska chinook and an unknown percentage of western Alaska chum salmon. Other GOA salmon bycatch originates from southeast Alaska and British Columbia runs. Spawning escapement of chinook and other salmon in southeast Alaska are stable and increasing in many of the management units.

The cumulative effects analysis was based on two groupings of Alaska salmon in BSAI and GOA: chinook salmon and other salmon. As stated in the assumptions above, 96 percent of other salmon caught in BSAI is considered to be chum salmon.

Direct/Indirect Effects

Direct and indirect effects to chinook salmon and other salmon in BSAI and GOA include mortality, changes to prey availability, genetic structure of population, and reproductive success.

BSAI – Chinook Salmon

Under FMP 1, chinook salmon bycatch in the BSAI varies from approximately 26,000 in 2003 down to 23,000 in 2008. 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 13,000 to 18,000 fish during the next six years. This harvest represents approximately 4.3 to 6.0 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. The effects of this level of bycatch are not detectable in natal streams and would have little or no effect on commercial or subsistence harvests or escapement. It is unlikely that this level of bycatch, when considered across all chinook salmon runs in western Alaska, would impact the sustainability of the stock and is therefore considered insignificant under FMP 1. However, given the current poor stock status of chinook salmon runs in western Alaska and considering the combined bycatch potential in BSAI and GOA, bycatch levels significantly higher from those predicted for FMP 1 could adversely impact recovery of depressed stocks.

BSAI – Other Salmon

Under FMP 1, bycatch of other salmon in BSAI varies from approximately 69,000 in 2003 down to 58,000 in 2008. 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 11,000 to 13,000 fish during the next six years. This harvest represents approximately 1.0 to 1.2 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. The effects of this level of bycatch are not detectable in natal streams and would have little or no effect on commercial or subsistence harvests or escapement. It is unlikely that this level of bycatch, when considered across all chum salmon runs in western Alaska, would impact the sustainability of the stock and is therefore considered insignificant under FMP 1. However, given the current poor stock status of chum salmon runs in western Alaska, harvest level higher than those predicted under FMP 1 could adversely impact recovery of depressed stocks.

GOA – Chinook Salmon

Under FMP 1, chinook salmon bycatch in the GOA varies from approximately 13,000 in 2003 up to 28,000 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 8,000 to 16,000 fish during the next six years. This harvest level represents approximately 2.6 to 5.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. The effects of this level of harvest are not detectable in natal streams and would have little or no effect on commercial or subsistence harvests and escapement. It is unlikely that this level of bycatch, when considered across all chinook salmon runs in western Alaska, would impact the sustainability of the stock and is therefore considered insignificant under FMP 1. Population-level effects of bycatch on depressed stocks are difficult to determine. However, given the poor stock status of chinook salmon runs in western Alaska and considering the combined bycatch potential in BSAI and GOA fisheries, bycatch levels significantly higher than those predicted for FMP 1 could adversely impact recovery of depressed stocks.

GOA – Other Salmon

Under FMP 1, bycatch of other salmon in GOA varies from approximately 5,000 in 2003 up to 11,000 in 2008. Assuming 56 percent of other salmon bycatch is chum salmon, the bycatch could range from 3,000 to 6,000 fish during the next six years. The proportion of these fish originating in western Alaska is unknown. Assuming that 100 percent of these fish were of western Alaska origin, this harvest represents approximately 0.3 to 0.5 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This level of bycatch is not detectable in natal streams and would have little or no effect on commercial or subsistence harvests and escapement. It is unlikely that this level of bycatch, when considered across all chum salmon runs in western Alaska, would impact the sustainability of the stock and is therefore considered insignificant under FMP 1.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 1 is shown in Tables 4.5-32 and 4.5-33. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant for FMP 1. The predicted level of bycatch would not be detectable in natal streams and would have little or no effect on commercial or subsistence harvests or escapement. It is unlikely that this level of bycatch, when considered across all salmon runs in western Alaska, would impact the sustainability of the stock. However, if currently depressed stocks continue to decline in the future, then possible adverse effects of mortality could exist for BSAI and GOA chinook and BSAI other salmon. The likelihood of these potential trends in salmon stocks throughout Alaska cannot be determined at this time.

- **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 years to follow, 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 this effect cannot be determined; however, current stock status of salmon runs in western Alaska are depressed. These fisheries are not considered contributing factors in mortality of other non-western chinook or other salmon populations. 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. 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 BSAI 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 1. Combined bycatch potential in the BSAI and GOA fisheries under this FMP could impact the successful recovery of depressed stocks in the BSAI and GOA and sustainability of the stocks as a whole. Current stock status GOA other salmon is considered stable, and combined effects of mortality on other salmon in this region resulting from direct catch, 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 1 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 both 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. 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. State hatchery enhancement programs exist in the GOA but do not include prey species of salmon.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 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 both 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. Significant impacts to genetic structure of salmon populations by land management practices are not expected and are not considered contributing factors to a possible change in baseline condition. Long-term climate change and regime shifts are not expected to result in direct mortality that would potentially affect genetic structure of the BSAI and GOA chinook and other salmon stocks. 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 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 1.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of FMP 1 on reproductive success for BSAI and GOA chinook and other salmon 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 salmon populations originating in the 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. Non-western Alaska salmon 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 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 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. Degradation of watersheds used by spawning salmon resulting from poor land management practices, could significantly impact the reproductive success of BSAI and GOA chinook and BSAI other salmon stocks. Thus, these practices are considered potential adverse contributions to changes in reproductive success of these populations.

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. For reasons stated above, land management practices are considered potential adverse contributors to the reproductive success of GOA salmon stocks. Hatchery enhancement programs in the GOA may help to restore depressed stocks and maintain stable stocks in Alaska and are considered potentially beneficial to populations of chinook and other 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. However, it is unknown whether these potential changes to stock status would be driven by changes in reproductive success, specifically, as a result of persisting past effects and reasonably foreseeable future external effects (human controlled and natural events). Current stock status of GOA other salmon is stable, but 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 at this time for GOA other salmon stocks under FMP 1.

4.5.2.3 Pacific Herring

Pacific herring are managed by the ADF&G. Harvest policy and allocations among gear (user) groups are 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.

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 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.

Under all FMPs, Pacific herring bycatch in groundfish fisheries is considerably lower than some of the highest catch years recorded following passage of Amendment 16A in 1991. Only under the relatively unrestricted fishing of FMP 2.1 does herring bycatch even begin to approach the levels of herring bycatch in the early 1990s.

However, it is somewhat disturbing that even with the relatively unrestricted fishing, the model's estimates of herring bycatch are less than those actually observed in 1990-92. Herring stock levels are thought to be approximately similar to those in the early 1990s. The lower herring bycatch portrayed by the model likely results from the use of highly aggregated and temporally-averaged bycatch rates. In the early 1990s, fishing vessels likely encountered dense concentrations of herring schools by chance. Temporally and spatially averaged bycatch rates will not simulate these occasional encounters, but will still represent an average herring bycatch long-term.

While these are the best data available for this modeling approach, they do represent averages over time and space. For a species with dense spatial aggregations that move dynamically through time, this may not be the best prediction of specific future scenarios. These scenarios assume that future distributions of fishing effort in space and time will be similar to those in the past. Given the available data, it is the best that can be done.

Population dynamics of Pacific herring are not explicitly modeled. Therefore the effects of the management measures on herring biomass are not evaluated. However, given the low herring bycatch levels under all of the scenarios, bycatch removals would not be expected to have a detectably different impact on herring abundance estimates.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 1 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 1 given the low amounts predicted for herring bycatch, and because 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.

- **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 rates. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have impacted herring populations 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 is also 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's 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, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under FMP 1, 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 for Pacific herring.

- **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 had long-term impacts on herring populations. 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. 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 and other state groundfish 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, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 1.

<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 1 because groundfish fisheries do not target herring prey and 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 are not a component of bycatch from state directed herring fisheries, state commercial 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.

<u>Change in Habitat</u>

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under FMP 1, 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 the groundfish fisheries were to somehow impact herring habitat, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring. In addition, the herring savings areas reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds.

- **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.

4.5.2.4 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). King, bairdi, and opilio Tanner crab are prohibited species for the state scallop and groundfish fisheries and Federal groundfish fisheries. This means that any crab bycatch must be discarded. Crab regulations focus on concerns about direct impacts to crab populations by trawling, considered trawl-induced mortality, and indirect impacts through habitat degradation as well. Because bycatch mortality is currently considered to be minor relative to other sources of mortality for crab, temporal and spatial closures are thought to be more effective than PSC limits in reducing impacts of trawling on crab stocks (Witherell and Harrington 1996). As such, numerous trawl closure areas have been instituted to address concerns about unobserved mortality (crab wounded or killed but not captured), and possible habitat degradation due to trawling and dredging.

With the exception of Norton Sound, Bristol Bay, and potentially the Pribilof Islands, all major western red king crab stocks are depressed and their associated fisheries are closed (ADF&G 2000). St. Matthew Island blue king crab was declared overfished in 1999 and the fishery closed. A rebuilding plan has been implemented. Red and blue king crab fisheries in the Pribilof Islands are closed and stocks considered either overfished or in decline. A rebuilding plan for the Pribilof Islands blue king crab stock is currently being developed. Golden king crab stock status in the BSAI and GOA is unknown due to lack of survey information. Bering Sea Tanner crab fisheries were closed in 1997 and stocks were declared overfished. A rebuilding plan is currently in effect for these stocks. Opilio Tanner crab populations in the BSAI are in decline and have been declared overfished. Overall status of bairdi Tanner and red king crab species in the GOA reflects population declines. However, blue and golden king crab are not actively assessed in the GOA at this time.

For the cumulative effects analysis, crab stocks in the BSAI and GOA will be placed in the following groups: bairdi Tanner, opilio Tanner (only BSAI), red king, blue king, and golden king.

Direct/Indirect Effects

Direct and indirect effects for all species of crab in the 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.

Cumulative Effects Analysis

Summaries of the cumulative effects analyses associated with FMP 1 are shown in Tables 4.5-35 through 4.5-42 . 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 up 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 also include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are each 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 1, predicted catch of these crab species does not significantly change from the current baseline condition although catch trends do increase and decrease 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. The level of crab bycatch predicted for 2003 through 2007 would not be expected to further impede the recovery of these already depressed stocks. Thus, the effects of FMP 1 on mortality of bairdi Tanner, opilio Tanner, red king, and blue king crab are considered insignificant, due to the lack of significant recovery of these stocks while protective measures have been in place.

- **Persistent Past Effects.** 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 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, these fisheries 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 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. 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 populations are 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's 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 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 1, predicted catch rates of golden king crab in BSAI and GOA were combined with those 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, the 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 1 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab in the BSAI during this time increased proportionally with the direct catch of these fisheries. However, this is only applicable for the BSAI because BSAI fisheries would not influence GOA stocks. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s 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.** 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 currently unknown. Thus, the potential effects of crab bycatch in other fisheries 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's 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 1.

Bairdi Tanner, Red King, and Blue King Crab in GOA

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, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under FMP 1, predicted catch of bairdi Tanner, red king, and blue king crab in GOA showed decreases from the current catch levels over the next five years. However, significance of these predicted changes in catch on mortality is unknown for blue king and bairdi Tanner crab due to lack of survey information for determining current stock status. Thus, the effects of FMP 1 on mortality of GOA blue king and bairdi Tanner crab are unknown. GOA red king crab surveys indicate the stock is depressed, with no signs of rebuilding. The level of red king crab bycatch predicted for 2003 through 2007 (63% lower than baseline conditions) would not be expected to further impede the recovery of the stock. Thus, the effects of FMP 1 on mortality of red king crab stocks are considered insignificant, due to the lack of recovery of these stocks while protective measures have been in place.

- **Persistent Past Effects.** 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.** 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 the 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 the 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 under FMP 1. Potential combined effects of mortality on red king crab stocks in the GOA are considered conditionally significant adverse. These 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 Biomass

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. Thus, FMP 1 would have an insignificant effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI, when compared to the current baseline condition of these stocks. The level of crab bycatch predicted for 2003 through 2007 would not be expected to further impede the recovery of these already depressed stocks. Thus, the effects of FMP 1 on the change in biomass of bairdi Tanner, opilio Tanner, red king, and blue king crab are considered to be insignificant, due to the lack of significant recovery of these stocks while protective measures have been in place.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the 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 could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. 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, these fisheries 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 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. Effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G's 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 resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events, are considered conditionally significant adverse. These effects could further jeopardize the sustainability of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI under FMP 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 1 on changes to biomass cannot be determined.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the 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. However, this is only applicable for the BSAI because BSAI fisheries would not influence GOA stocks. 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 the 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 and current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal 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 the BSAI and GOA is unknown and biomass estimates have not been determined. Thus, the potential effects of external fisheries on biomass are not known. Effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G's 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 the 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 1.

Bairdi Tanner, Red King, and Blue King Crab in GOA

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, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 1 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 1 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, the predicted reduction in bycatch of red king crab under FMP 1 would have an insignificant effect on the biomass of these stocks when compared to the current baseline condition.

- **Persistent Past Effects.** Crab bycatch is common in certain 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 and unobserved mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in the 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 occur and current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal 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 the GOA. Effects of long-term climate change and regime shifts on biomass have not been determined.

- **Cumulative Effects.** ADF&G's 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 the GOA, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 1. Potential effects on biomass of red king crab in the GOA are considered conditionally significant adverse. 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. Thus the potential effects of FMP 1 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the 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 the BSAI. 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. 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. A relationship between spawning-recruitment success and other factors impeding on reproductive potential with depressed stock status cannot be drawn at this time, the potential effects on reproductive success, resulting from past events, direct catch, bycatch, and future events, are unknown under FMP 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 the BSAI and GOA, potential effects of FMP 1 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the 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. However, this is only applicable for the BSAI because BSAI fisheries would not influence GOA stocks. 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 may exist, and internal effects are uncertain due to the lack of survey information. Potential effects on reproductive success, resulting from past events, direct catch, bycatch, and future events, are therefore, unknown for FMP 1.

Bairdi Tanner, Red King, and Blue King Crab in GOA

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, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in the GOA, potential effects of FMP 1 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, the relationship between reproductive success and depressed stock status for these stocks cannot be concluded at this time. Therefore, the potential effects of FMP 1 on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in the 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.** 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. Because a direct causation between reproductive success and depressed stock status cannot be concluded at this time, the potential effects on reproductive success, resulting from past events, direct catch, bycatch, and reasonably foreseeable future events are unknown under FMP 1.

<u>Change in Prey Availability</u>

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in BSAI and GOA

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, only BSAI opilio Tanner crab is included in this analysis.

- **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 1 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 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 the BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** 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 the 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 possible 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 the BSAI and GOA.

<u>Change in Habitat</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. 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 the BSAI. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for most crab stocks, thus the potential effects of FMP 1 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. 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. These fisheries are considered potential 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 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 also offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect but 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 in possible changes that may occur.

- **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. However the relationship between changes to habitat and depressed stock status cannot be drawn at this time. 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 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 the BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout the BSAI and GOA. Therefore, the potential effects of FMP 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.** Although some of the known habitat areas of the 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. These fisheries are considered potential 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 in possible changes that may occur.

- **Cumulative Effects.** It is unclear if persistent past effects on golden king crab habitat in the BSAI and GOA exist. Population estimates are not available for BSAI and GOA golden crab, although some GOA golden king crab stocks are considered depressed. The relationship between habitat and depressed stock status cannot be drawn at this time. 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, the potential effects on golden king crab habitat, resulting from past, present, and future events cannot be determined for FMP 1 without first establishing the overall population status of this species.

Bairdi Tanner, Red King, and Blue King Crab in GOA

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, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Red king and bairdi Tanner 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. However, the relationship between changes to habitat and depressed stock status cannot be drawn at this time. 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, thus the potential effects of FMP 1 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 areas 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.** Although some 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. These fisheries are considered potential 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 that may occur.

- **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. However, the relationship between changes to habitat and depressed stock status cannot be drawn at this time. 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 1.

4.5.3 Other Species Alternative 1 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 (*Ocotopus 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. Observer coverage in the BSAI is estimated at 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). Management of the Other Species category 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. With the exception of skates, none of the species in the other species category is currently targeted by the BSAI and GOA groundfish fisheries. Other species are only caught as bycatch by fisheries targeting groundfish. While we report changes in bycatch relative to the comparative baseline, determinations cannot be made as to how these changes in catch actually impact other species populations, or whether these impacts might be adverse, beneficial, or neutral. Numerous direct and indirect effects may impact the current and future status of individual species within this group or this group as a whole. These effects are presented in detail in the section that follows.

Direct/Indirect Effects FMP 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 is 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 1 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 1, total catch of both BSAI squid and other species and GOA other species is predicted to increase by several thousand mt per year, 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 the BSAI and GOA. Catch projections for specific groups within BSAI and GOA other species are presented below.

Squid

In the BSAI, squid catch is predicted to increase slightly and then decrease to the current level over the five projection years, likely following trends in the pollock fishery. In the GOA, squid catch is predicted to double over the five year projection period, 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.

Sculpin

Catches of BSAI sculpins are predicted to increase slightly (by 500 mt relative to current catches). GOA sculpin catch is predicted to increase by 200 mt per year over the projection period.

Shark

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 remain stable throughout the projection period under FMP 1. As in the BSAI, shark catches in the GOA are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark. Although 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 remain relatively similar 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 increase by nearly 2000 mt to over 21,000 mt within the first three projection years, and remains in that range for the remainder of the modeled period. The increased catch of skate may reflect increased catches in both longline fisheries for Pacific cod and in bottom trawl fisheries for cod and flatfish. In the GOA, skate catch is predicted to increase by about 1,300 mt, which is the same order of magnitude as current catches. This projected catch trend may warrant increased management attention if it actually occurred.

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 300-400 mt per year. Observed GOA octopus catch has been low historically, so changes to catch level may not cause different population impacts than current catch levels. 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 FMP 1 – Other Species

A summary of the cumulative effects analysis associated with FMP 1 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under FMP 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 of 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 non-specified 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, therefore, 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 FMP 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 non-specified 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 is 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, therefore, unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in the BSAI and GOA are unknown under FMP 1. The current baseline condition is unknown, and the 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 non-specified species. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups have 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 is 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, therefore, unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under FMP 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 non-specified 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, therefore, unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species are unknown under FMP 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, therefore, unknown.

4.5.4 Forage Fish Alternative 1 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 FMP 1 – BSAI and GOA Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. It is thought that the effects of FMP1 are unlikely to affect biomass of forage species.

Catch/Fishing Mortality

A directed fishery on forage species is prohibited by Amendments 36 and 39 in the FMPs for the BSAI and GOA, respectively. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (greater than 90 percent most years) of the forage fish bycatch, in both the BSAI and GOA, is made up of smelt species (Osmeridae) from the pollock fishery.

In the BSAI region, model projections for FMP 1 indicate incidental catch of forage fish would remain low at a level similar to the current catch (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 1 (Table H.4-41 of Appendix H). This increased pollock catch under this alternative is projected to lead to greater incidental catches of forage fish.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. Spatial or temporal concentration of fishing effort is not expected to change from the current pattern under FMP 1. Consequently, there is no evidence that any change in spatial or temporal fishing mortality of forage fish would occur.

Status Determination

The MSST of forage fish species is unknown at this time but it is highly unlikely that management practices under FMP 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. However, it is thought that FMP 1 would have little affect on the age and size composition of forage fish. 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 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. Attempting to accurately model the predator-prey impacts of different management FMPs is problematic. However, since FMP 1 is similar to the current management practices it seems unlikely that any significant changes would occur.

Summary of Effects of FMP 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 analysis of the FMP's 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 1 is incidental take of forage fish in other fisheries.

The model projects 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, taken mainly by 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 1 the bycatch of forage fish in the BSAI remains consistently low at a level slightly higher than the baseline (Table H.4-22 in Appendix H). In the GOA the bycatch of forage species is projected to increase considerably in the next 5 years (Table H.4-41 in Appendix H). Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 1 is thought to be a relatively small fraction of the biomass and unlikely to effect the abundance of the stock in the BSAI.

Indirect effects of FMP 1 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 1.

Cumulative Effects FMP 1 – 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 1.

- **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 indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause forage fish 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 forage fish. See Sections 3.5.4 and 3.10 for more information. 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 1 is rated as unknown.

- **Persistent Past Effects** have not been identified for the change in biomass of the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on the change in biomass are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.4 and 3.10. The Alaska subsistence and personal use fisheries have been identified as a potential adverse contributors 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 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 in water temperature.

- **Reasonably Foreseeable Future External Effects** on the reproductive success of forage fish due to climate changes and regime shifts are potential beneficial or adverse. 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 and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as having potential 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 be large enough and taken in such a localized manner that would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect is identified 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 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 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects** of the climate changes and regime shifts on the BSAI and GOA forage fish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stocks ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potential 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 identified for change in prey availability; however, this effect is unknown, because the information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 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. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information, 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 potential 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. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish habitat suitability. For more information on the effects of fishery gear on EFH, see Section 3.6.4.

- **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.

Summary of Cumulative Effects – BSAI and GOA Forage Fish

Although cumulative effects have been identified for mortality, change in biomass level, change in genetic structure, change in reproductive success, change in prey availability and change in habitat suitability, all effects are unknown except for mortality. Mortality has been identified as insignificant (see Tables 4.5-44 and 4.5-45).

4.5.5 Non-Specified Species Alternative 1 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 make up a huge and diverse category encompassing every species not listed in the current FMP as 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), we discuss potential effects to grenadier only.

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 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, 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 1 are relatively small, such that diverse alternatives may have similar (though unknown) effects on each stock.

Under FMP 1, catch of grenadiers in both the BSAI and GOA is predicted to remain within 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 FMP 1 – Non-Specified Species

A summary of the cumulative effects analysis associated with FMP 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.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 1. The current baseline condition is unknown and 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 of the non-target species bycatch in the GOA, and mortality is therefore 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 the 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, therefore, unknown for FMP 1.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadiers is unknown under FMP 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 therefore, 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 would 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, therefore, unknown for FMP 1.

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 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 to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. Such 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, would 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, therefore, unknown for FMP 1.

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 1. The current baseline condition is unknown, and the 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 to the genetic structure of the population if genetic composition within these species groups have 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, therefore, unknown for FMP 1.

4.5.6 Habitat Alternative 1 Analysis

Habitat protection measures under FMP 1 result from a long history of fishery management actions. The majority of historical management actions that addressed habitat concerns focused on protection of crab habitat.

Figure 4.2-1 illustrates the current suite of year-round closures in the BSAI and GOA management areas. Table 4.5-47 summarizes the baseline and FMP 1 geographic and habitat type distribution of bottom trawl closures in waters less than 1000 m. In the GOA and Aleutians Islands, nearly all of these closures are located in shallow waters (less than 100 m); near-shore state waters (GOA only), within 3 miles of sea lion rookeries, or Type I closures around Kodiak Island. In deeper areas, with the exception of the eastern GOA (area 650), only 0-7 percent of the fishable area is currently protected from the impacts of bottom trawling. In the Bering Sea most of the closures are concentrated on sand substrate believed important to crab. There are limited closures on sand/mud substrate and no closures on mud habitat. There are no closures on the upper slope of the Bering Sea, although this area is not considered by some to be a distinct habitat type (see Section 3.6 for a discussion of existing closures and their intended habitat effects).

Direct/Indirect Effects of FMP 1

Direct and indirect effects of FMP 1 are discussed for changes to living habitat through direct mortality of benthic organisms, changes to benthic community structure through benthic community diversity, and geographic diversity of impacts and protection. Due to habitat type differences, the BSAI and GOA are rated and discussed separately.

Changes to Living Habitat through Direct Mortality of Benthic Organisms

In the GOA, based on the bycatch projection model, the catch of most living habitats is projected to decline (Table 4.5-48). In the BSAI, the bycatch levels are predicted to be within about plus or minus 20 percent of the baseline. The model projections for the GOA are unrealistically low relative to the baseline. This is because specific fisheries that have high bycatch of living substrates, such as aggregated rockfish, are constrained within the model framework (Jim Ianelli, AFSC personal communication). Based on past performance, it is doubtful that such constraints will severely curtail the rockfish fishery. A more realistic assumption is that bycatch levels would be about the same as the baseline, which are at levels considered to cause adverse impacts to habitat.

The habitat impacts model predicts the following effects for biostructure relative to the baseline:

- **Bering Sea.** There is no predictable difference from the baseline. Mean impacts are low when averaged over entire fishable EEZ. As with the baseline, impacts to biostructure range 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 expanse (8,000 square miles) of high fishing intensity potentially causes an 83 percent reduction in equilibrium biostructure level for scenario 2 (i.e., 15 year recovery rate). Based on these results, we conclude that change to mortality and damage to living habitat would be insignificant as a result of FMP 1. Thus the rating is based on the insignificant change between FMP 1 projections and the comparative baseline.

- **Aleutian Islands.** There is no predictable difference from baseline where mean 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, the change resulting from FMP 1 is rated as insignificant. However, prevalence of long-lived species of coral in the bycatch makes impacts a particular concern under FMP 1. 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 is estimated to be fished at $f = 0.10$ or greater. This amounts to 3,590 square miles of area. 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 1; however, as with the baseline, FMP 1 bycatch levels may have adverse consequences on habitat quality and FMP 1 would not change this risk.

- **GOA.** There is no predictable difference from the baseline where estimates of equilibrium impact on biostructure averaged over the entire fishable EEZ range from 0.9 to 6.9 percent of the fishable area and from 3.8 percent to 29.0 percent of the fished areas. Only 2 percent of the fishable EEZ is impacted to a level potentially below 32 percent (Scenario 2) of unfished levels, but this amounts to about 2,418 square miles of habitat in scattered concentrations. Therefore, for FMP 1, the change to mortality and damage to living habitat is rated as insignificant. However, as described above, the baseline condition is considered to already be adversely impacted.

Changes to Benthic Community Structure including Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Identical to the baseline, FMP 1 closures in the Bering Sea are mostly concentrated on sand substrate (Table 4.5-47). Only 27 percent of the geographical- habitat zones have greater than or equal to 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 square miles (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 1. However, very little geographic diversity of fishing impacts occurs within the closed habitats and nearly all of the closures are not 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 the sensitivity and recovery parameters thought plausible, fishing of this intensity could reduce the amount of biostructure in the area by 13 to 75 percent of its unfished equilibrium level (Table 4.1-26). Such biostructure includes sponges, soft corals, tunicates, and anemones (Heifetz *et al.* 2002, Malecha et al. 2003). In these habitat areas, no existing closure areas abut these intensely fished areas to provide a diverse level of impact. While existing closures tend to be large and cover all of 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 1 on benthic community diversity are insignificant. Similarly, the predicted effects of FMP 1 on geographic diversity of impacts are also predicted to be insignificant. However, as described above for direct mortality, the baseline condition is considered to already be adversely impacted.

- **Aleutian Islands.** Identical to the baseline, FMP 1 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 this FMP. 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 extends over any blocks of significant fishing effort. Figures 4.5-4 and 4.5-5 show the closure areas under FMP 1 broken down by gear type, bottom trawl and fixed gear, respectively. The Aleutian Islands bathymetry and habitat are distributed on a very fine scale, with fishing effort that is very patchy and in very small clusters. Based on these observations as compared to the baseline, the predicted effects of FMP 1 on benthic community diversity and geographic diversity of impacts are insignificant, but the baseline condition is considered to have experienced adverse impacts.

- **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, none exist on the outer shelf or slope (see Figure 4.5-6). As shown on Table 4.5-49 and Figures 4.5-4 and 4.5-5, FMP 1 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 much of a bathymetric feature. Based on these results, the predicted effects of FMP 1 on benthic community diversity and geographic diversity of impacts are insignificant, but the baseline condition is considered to be in an adversely impacted state.

Cumulative Effects FMP 1

Cumulative effects on Habitat for FMP 1 are summarized on Table 4.5-50. The following discussion of the results presented on the table is broken down by geographic area.

Bering Sea

<u>Changes to Living Habitat through Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant, but 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 sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be 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 which include mortality due to smothering and/or 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 and, of course, would only affect nearshore zones and bays. Marine pollution is also 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 benthic organisms. Again areas more likely to be impacted would be located 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.** Conditionally significant adverse effects are identified for mortality of Bering Sea benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the effect of FMP 1 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue and add to the adverse consequences to benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant; however, the community structure 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). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, all have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above, all of these impacts are more likely to be observed in nearshore areas. Regime shifts and large-scale environmental fluctuations associated with El Niño and La Niña 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.** Conditionally significant adverse effects are identified for changes in benthic community structure of the Bering Sea. The additional external impacts will add to the lingering past impacts described above. The additional external impacts described above 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 1 are rated as insignificant, continued bycatch and damage to living habitats in the Bering Sea will add to the adverse effects of fishing on the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant; however, the geographic diversity 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 illustrate the spatial measures that were in effect before 1980 or were later established by regulations following the 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 to prevent conflicts with domestic fisheries through bycatch of species important to U.S. fishermen, or grounds preemption and gear conflicts. At the time, 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 again 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.** These include port expansion and the potential resultant changes to offal discharge and marine pollution episodes. As 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. Of course, 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 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.** Conditionally significant adverse effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 1 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 1 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 particular habitat, and they provide little diversity in fishing impacts since the primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear; see internal effects discussion and baseline description in Section 3.6). The 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 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.

Aleutian Islands

Changes to Living Habitat through Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant, but 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. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be 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 due to 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. As with Bering Sea processors, 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. The impacts include mortality due to smothering, and/or burying and, would affect only nearshore zones and bays. Marine pollution is also 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 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.** Conditionally significant adverse effects are identified for mortality of Aleutian Islands benthic organisms. Long lived species such as tree coral are more prevalent in the Aleutian Islands. The additional external impacts described above 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 1 are rated as insignificant, bycatch and damage to living habitat will continue and will add to the adverse consequences to benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant; however, the community structure 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 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be 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 long-term, as in the case of a change to a weather pattern, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above for mortality, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with El Niño and La Niña 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.** Conditionally significant adverse effects are identified for changes in benthic community structure of the Aleutians. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident, particularly in the case of long-lived coral species. Thus, even though the direct/indirect effects of FMP 1 are rated as insignificant, continued bycatch and damage to living habitat will add to the adverse consequences on the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed above 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 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.** These 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 additionally be impacted or allowed to recover. As with the Bering Sea, ports in the Aleutians are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, these additional ports and harbor space could change the distribution of fishing efforts. Of course, 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 disturbance to the bottom, offal discharge and marine pollution. For example, under FMP 1, areas previously closed to foreign trawl fishing, such as Unimak Pass, are now fished by the domestic trawl fleet. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 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 will not protect the full range of habitat types, or provide for a diversity of impacts within fished areas. The 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 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

<u>Changes to Living Habitat through Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant, but 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. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As described for the Bering Sea and Aleutian Islands, 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. The impacts, which include mortality due to smothering and/or burying, would likely only affect nearshore zones and bays. Marine pollution is also 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 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.** Conditionally significant adverse effects are identified for mortality of GOA benthic organisms. The additional external impacts described above 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 1 are rated as insignificant, bycatch and damage to living habitat will continue and add to the adverse consequences to benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant; however, the community structure 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 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be 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 long-term, as in the case of a change to a weather pattern, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with El Niño and La Niña 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.** Conditionally significant adverse effects are identified for changes in benthic community structure of the GOA. The additional external impacts described above will add to the lingering past impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 1 are rated as insignificant, bycatch and damage to living habitat will continue and will add to the adverse consequences to benthic living habitat.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent 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). This again 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 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 concerned 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 one time or another throughout the year.

- **Reasonably Foreseeable Future External Effects.** These 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 described for the other areas, as ports in the GOA are expanded, new ports created, and additional dock space for harboring the fishing fleet is made available, and changes in the distribution of fishing effort could result. 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.** Conditionally significant adverse effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 1 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 FMP 1 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 1 (less than one 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 described above will add to the lingering impacts and contribute to impacts that are already evident. This is particularly important since FMP 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.

4.5.7 Seabirds Alternative 1 Analysis

4.5.7.1 Short-Tailed Albatross

Direct/Indirect Effects of FMP 1

<u>Incidental Take</u>

Incidental take of the endangered short-tailed albatross in the groundfish fishery is a very rare event, with the last recorded takes occurring in 1998 (see Section 3.7.4 for a history of takes and agency actions taken to protect this species under the ESA). The seabird protection measures on the longline fleet have been in place since 1997 and constitute the baseline condition for this analysis (see Appendix F-6). These measures have been strongly influenced by the goal of protecting short-tailed albatross. These measures did not eliminate incidental take of short-tailed albatross, as evidenced by two takes in one month in 1998. A great deal of research and development has been conducted since that time to improve the current seabird protection measures. FMP 1 would institute new protection measures based on the joint recommendations of NOAA Fisheries, USFWS, and the Washington Sea Grant Program. These new regulations are currently undergoing agency and public review before being enacted (68 FR 6386). These new regulations are expected to substantially reduce the incidental take of all surface-feeding seabirds and therefore reduce the chance of taking short-tailed albatross. NOAA Fisheries and USFWS are currently researching the risk of short-tailed albatross incidental take due to collisions with trawl third wires. FMP 1 would incorporate any mitigation measures that arise from this research if it is considered necessary to protect the species.

Given the extreme rarity of short-tailed albatross, numbering less than 2,000 birds worldwide, any level of mortality is a conservation concern. For this reason, management actions that substantially reduce the chance of human-caused mortality even if the chance is not totally eliminated, have been pursued under the ESA and are included under FMP 1. From the perspective of research, management, and fishing industry efforts to reduce the chance of taking short-tailed albatross, the new protection measures have been very substantial. However, the short-tailed albatross population has been increasing at a near-maximum rate under the baseline conditions so a reduced chance of mortality in the fishery, when the measurable frequency of that mortality already approaches zero, may not result in measurable benefits for the population. The reduced level of incidental take under FMP 1 is therefore considered to be insignificant at the population level for short-tailed albatross.

Changes in Food Availability

Short-tailed albatross forage over vast areas of ocean on prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Sections 4.5.4 and 4.5.10). Short-tailed albatross are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 1. FMP 1 is therefore considered to have insignificant effects on short-tailed albatross.

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 1. FMP 1 is therefore considered to have no effects on short-tailed albatross.

Cumulative Effects of FMP 1

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 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 4.5-52.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures on the longline fleet should substantially reduce the chances of taking short-tailed albatross incidentally in the groundfish fishery, although the risk would not be eliminated. Incidental take of short-tailed albatross is therefore predicted to be a very rare event in the groundfish fishery and is considered insignificant at the population level.

- **Persistent Past Effects.** The most important persistent influence on the short-tailed albatross population is their near extinction due to commercial feather hunting from the late 1800s to 1932 (Hasegawa and DeGange 1982). Conservation efforts in Japan and the U.S. have helped secure and expand nesting locations and reduce human-caused mortality factors such as incidental take in fisheries, allowing the population to recover at or near to its biologically maximum rate. Given the lack of observers and incidental take data from most of the fisheries in their range, the total fishery-related mortality of short-tailed albatross is unknown. However, considering their recent rate of population growth, overall mortality does not appear to be having an overriding effect on the population.

- **Reasonably Foreseeable Future External Effects.** The primary concern for the future of the species' complete recovery is the risk presented by volcanic eruptions on their main breeding site, Torishima Island. If a major eruption occurred while the birds were nesting, a significant proportion of the breeding adults could be killed along with their eggs/chicks. Such a disaster would not cause the species' extinction, since many non-breeding birds would be at sea and there are alternative nesting sites, but it would place even greater importance on each human-caused mortality, no matter how rarely it occurred. It may lead to further efforts to protect the species from fishery interactions. The recovery rate of the species will also depend on maintaining a very low incidental take rate for all fisheries in their range. Major expansions in fishing effort, changes in gear types, or creation of new fisheries could lead to small changes in overall incidental take that could have measurable population level effects.

- **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 under FMP 1, the cumulative effect on short-tailed albatross is considered to be conditionally significant adverse at the population level.

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 1. This effect is considered insignificant at the population level for short-tailed albatross. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on short-tailed albatross prey populations cannot be assessed at this time.

- **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. The collapse of the short-tailed albatross population was due to direct harvest rather than loss or change of habitat. The growth rate of the population should therefore not be limited by the carrying capacity of the environment, which once supported millions of birds, in the foreseeable future. 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, cannot 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.

4.5.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of FMP 1

Incidental Take

The incidental take of Laysan and black-footed albatross are reported in the Observer Program data from 1993-2001 and include the unidentified albatross and an unknown number of the unidentified tubenoses (Tables 3.7-1 through 3.7-5). The number of albatross taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated number of Laysan albatross taken in this period averaged 650 birds per year in the BSAI longline sector (including a share of the unidentified albatross category), 126 birds per year on GOA longlines, and 90 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for a total estimated average take of 866 birds per year in the groundfish fishery. The latest population estimate for the species is 2.4 million birds (Cousins *et al.* 2000). Mortality from the groundfish fishery under the baseline conditions is thus estimated at 0.04 percent of the population and is therefore considered insignificant. For black-footed albatross, estimated mortality in the groundfish fisheries averaged 12 birds per year in the BSAI longline sector (including a share of the unidentified albatross category) and 158 birds per year on GOA longlines (with no observed takes in the BSAI and GOA trawls), for a total estimated average take of 170 birds per year in the groundfish fishery. The latest population estimate for the species is 300,000 birds (Cousins and Cooper 2000). Mortality from the groundfish fishery under the baseline conditions is thus estimated at 0.06 percent of the population and is therefore considered insignificant.

The baseline seabird protection measures for longline vessels were developed in large part to protect short-tailed albatross but were based on the deterrence of northern fulmars and the albatross species in this group (see Appendix F-6 for a discussion of the effectiveness of the present seabird protection measures). Similarly, the new seabird protection measures that would be enacted under FMP 1 (68 FR 6386) were based in part on the substantial reduction of incidental take of Laysan and black-footed albatross using paired tori lines (Melvin *et al.* 2001). NOAA Fisheries is currently in the process of finalizing the new seabird deterrent regulations for the longline fleet. However, most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season. Incidental take data from the 2002 season should therefore give some indication of the potential effectiveness of the new regulations in reducing take of albatross. Seabird incidental take data are reported in the annual SAFE, Ecosystems Considerations Report. Data from the 2002 season will be available in the 2003 SAFE (NPFMC 2003b) (see Comment Analysis Report for updated statistics and analysis).

NOAA Fisheries and USFWS are currently researching the potential impact of incidental take due to collisions with trawl third wires. FMP 1 would incorporate any mitigation measures that arise from this research if it appears to reduce the chances of incidentally taking short-tailed albatross. This assessment would likely be made on the basis of a measured reduction in the take of Laysan albatross in lieu of short-tailed albatross, as was done for the longline protection measures. Potential future mitigation of take from trawl third wire collisions would therefore reduce incidental take of Laysan albatross and perhaps black-footed albatross as well.

While the management measures proposed under FMP 1 can be justified by various statutory conservation directives and would be expected to reduce the incidental take of albatross relative to the baseline condition, the level of incidental take for these species under the baseline conditions is considered to be insignificant at the population level.

Changes in Availability of Food

Albatross forage over vast areas of ocean on prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections 4.5.4 and 4.5.10). Albatross are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 1. FMP 1 is therefore considered to have insignificant effects on albatross.

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 1. FMP 1 is therefore considered to have no effects on these species.

Cumulative Effects of FMP 1

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 1 are described above (Table 4.5-53). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the contribution of this fishery to the overall mortality of albatross. Expected incidental take of both species is considered insignificant at the population level.

- **Persistent Past Effects.** Both of these albatross species have been subjected to various human-caused mortality factors in the past, including hunting on their nesting colonies and incidental take in net and longline fisheries. For black-footed albatross, estimated incidental take in U.S. and foreign North Pacific longline fisheries has exceeded the maximum amount of anthropogenic mortality (10,000 birds per year) that can be sustained by a stable population according to population modeling (Cousins and Cooper 2000). Census data from their breeding grounds in Hawaii indicate an overall decline in population of 1.3 percent per year over the past decade (NMFS 2001d). The great majority of past mortality has been in the foreign longline fleets (estimated at approximately 20,000 birds per year) while the Hawaiian longline fleet has taken an average of 1,700 birds per year and the BSAI/GOA groundfish fisheries have averaged about 250 birds per year since 1997.

  Laysan albatross have been taken in huge numbers in the past by feather hunters and in fisheries. Numbers of breeding pairs in Hawaii have declined substantially in the past decade. Since Laysan albatross have a conservative life history strategy that depends on high adult survival rates, mortality of adults in fisheries (or any other source) can have delayed and lingering adverse effects on the population. While some major sources of mortality have been eliminated (feather hunting ended in the 1930s, high-seas driftnet fishing ended in 1991), incidental take in longline fisheries has been substantial in the recent past. Applying the results of the black-footed albatross population model as an approximation for Laysan albatross, the threshold of maximum anthropogenic mortality that could be sustained by a stable population would be about 80,000 birds per year (3.3 percent of the estimated population). Mortality rates less than this value could also have measurable population level effects by reducing the rate of recovery from a decline, especially during periods of poor reproductive success such as might occur from oceanic regime shifts. Foreign North Pacific longline fisheries have taken an estimated 15,000 Laysan albatross per year while the Hawaiian pelagic longline fisheries took an average of 1,330 birds per year and the BSAI/GOA groundfish fisheries took an average of about 770 birds per year on longlines. There are no reliable incidental take data from other North Pacific longline fisheries such as the halibut fisheries. A smaller number of Laysan albatross were taken in groundfish trawls and were killed in vessel strikes. The numbers of Laysan albatross killed in similar trawl and net fisheries throughout their range is unknown. The known mortality from these fisheries adds up to less than one percent of the estimated population and does not appear to be enough to account for the observed decline in Hawaiian breeding pairs. A number of other factors may be partly responsible for the decline, including lingering effects from high-seas driftnet mortality, mortality from acute and chronic effects of pollution such as plastics and toxic compounds, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation). It is not known what combination and proportion of factors are responsible for the observed population decline.

- **Reasonably Foreseeable Future 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. The United Nations Committee on Fisheries established an international plan for reducing seabird bycatch in longline fisheries (FAO 1999) that calls on member states to voluntarily develop guidelines or regulations for their fisheries. However, these national plans are likely to be inconsistent in their efficacy and enforcement in the foreseeable future. It is therefore expected that incidental take of black-footed and Laysan albatross in foreign longline fisheries will remain high and will 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 1, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level.

<u>Changes in Food Availability</u>

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 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 seabird prey populations cannot be assessed at this time.

- **Persistent Past Effects.** 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 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 has potentially affected albatross prey in the past. However, very little is known about the specific toxicological effects on prey species important to these albatross 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, cannot 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 their prey. Therefore, no cumulative effect is identified for these species.

4.5.7.3 Shearwaters

Direct/Indirect Effects of FMP 1

<u>Incidental Take</u>

The incidental take of shearwaters is reported in the Observer Program data from 1993-2001, including an unknown number of the unidentified tubenoses (Tables 3.7-1 through 3.7-5). The number of shearwaters taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated mortality of shearwaters in the groundfish fisheries averaged 578 birds per year in the BSAI longline sector, 18 birds per year on GOA longlines, and 799 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for a total estimated average take of 1395 birds per year in the groundfish fishery. Population estimates of short-tailed and sooty shearwaters are 23 million and 30 million birds, respectively (Everett and Pitman 1993, Springer *et al.* 1999). Incidental take of these species in the groundfish fisheries under the baseline conditions is much less than 0.01 percent of their populations and is thus considered insignificant.

The new seabird protection measures that would be enacted under FMP 1 (68 FR 6386) were developed in large part to protect short-tailed albatross and were based on the substantial reduction of incidental take of other albatross using paired tori lines (Melvin *et al.* 2001). However, shearwaters are able to dive deeper than albatross and the new deterrent devices did not change the rate of incidental take of these species. NOAA Fisheries and USFWS are currently researching the potential impact of incidental take due to collisions with trawl third wires. FMP 1 would incorporate any mitigation measures that arise from this research if it appears to reduce the chances of incidentally taking short-tailed albatross. It is not clear at this point whether shearwaters are also susceptible to collisions with trawl gear or whether any potential mitigation measures for albatross would reduce incidental take of shearwaters as well. Although the seabird protection measures proposed under FMP 1 may not reduce incidental take of shearwaters, there is no indication that they would increase take of these species. Since the level of incidental take for both shearwater species is considered to be insignificant under the baseline conditions, incidental take under FMP 1 is also considered to be insignificant at the population level for both shearwater species.

Changes in Food Availability

Shearwaters forage over vast areas of ocean on planktonic prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections 4.5.4 and 4.5.10). Shearwaters are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 1. FMP 1 is therefore considered to have insignificant effects on shearwaters 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 1. FMP 1 is therefore considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 1

The past/present effects on both 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 1 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 effects considered in this analysis are listed in Table 4.5-54.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would not be expected to reduce the contribution of this fishery to the overall mortality of shearwaters. Expected incidental take of both species is considered insignificant at the population level.

- **Persistent Past Effects.** Both species of shearwaters have been subjected to various human-caused mortality factors in the past, including hunting on their nesting colonies and incidental take in net and longline fisheries. Sooty and short-tailed shearwaters are so abundant and so widespread in the Pacific Ocean that it is very difficult to estimate their populations and hence very difficult to determine if their populations are fluctuating in response to any set of conditions. Chicks of both species have been and are likely to continue to be harvested in massive numbers on their breeding grounds for both subsistence and commercial purposes. Many other fisheries throughout their huge range have taken them incidentally, although the total number of these mortalities is unknown. This situation is likely to continue in the future. The number of shearwaters taken in the BSAI/GOA groundfish fisheries has been relatively small (about 600 birds per year in the longline fisheries and about 800 birds per year in trawls). There is some evidence to suggest that both populations may be declining on their breeding grounds but the scope and mechanisms for these declines have not been established.

- **Reasonably Foreseeable Future Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets that are similar to those proposed for the Alaskan fisheries. These measures are not expected to reduce incidental take of shearwaters in those fisheries. The United Nations Committee on Fisheries established an international plan for reducing seabird bycatch in longline fisheries (FAO 1999) that calls on member states to voluntarily develop guidelines or regulations for their fisheries. However, these national plans are likely to be inconsistent in their efficacy and enforcement in the foreseeable future. It is therefore expected that incidental take of shearwaters in foreign longline and trawl 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 and are expected to continue in the future, including contributions from the groundfish fisheries under FMP 1, the cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally significant adverse at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid as bycatch under FMP 1. This effect is considered insignificant at the population level for both shearwater species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on shearwater prey populations cannot 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 have potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on prey species important to these species 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, cannot 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 all species.

<u>Benthic Habitat</u>

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.

4.5.7.4 Northern Fulmar

Direct/Indirect Effects of FMP 1

<u>Incidental Take</u>

Northern fulmars make up a majority of all birds taken in all three gear sectors. The numbers of fulmars taken are reported in the Observer Program data under their own species listing plus an unknown number of the unidentified tubenoses and unidentified seabird groups (Tables 3.7-1 through 3.7-5). The number of fulmars taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated number of fulmars taken in this period averaged 10,689 birds per year in the BSAI longline sector, 406 birds per year on GOA longlines, 3,083 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, and 42 birds per year in BSAI and GOA pots, for an estimated average identified take of 14,220 birds per year in the groundfish fishery. This total does not include any portion of the "unidentified seabird" category in the data set or any estimate of birds killed by vessel strikes. Given the high proportion of fulmars in the identified categories, one could reasonably assume that a large number of the unidentified bird remains were actually fulmars. For this analysis, the portion of unidentified birds in the data that were actually fulmars will be approximated as an additional 1,000 birds per year, mostly from the BSAI longline sector. Vessel strike data have been collected in an *ad hoc* manner but existing records indicate that an average of at least 80 fulmars are killed each year by trawl third wires (NOAA Fisheries is currently researching the nature and extent of this mortality factor). Adding these approximations to the identified fulmar takes gives a total estimated average take of about

15,300 birds per year from all fisheries. The latest population estimate for fulmars in the BSAI and GOA is about 2 million birds, with 4 to 5 million in the North Pacific (Hatch and Nettleship 1998). Mortality from the groundfish fishery is thus equal to about 0.76 percent of the BSAI and GOA population.

This level of incidental take is considered to be insignificant at the overall population level. However, because fulmars only breed in a few large colonies in the BSAI/GOA, there is some concern that incidental take from the fisheries could have a colony level effect if a disproportionate amount of the overall take comes from only one colony, particularly the Pribilof Islands since it is the smallest colony. The USFWS has established permanent sample plots on the Pribilof Islands but the usefulness of those census plots to measure potential colony level changes of fulmars is questionable (see Section 3.7.5). The U.S. Geological Survey/Biological Resource Division (USGS/BRD) has recently begun to research the issue using satellite telemetry and genetic analysis to determine the movement patterns of fulmars and the colony of provenance of birds taken in the fishery. Other factors that may cause population levels to fluctuate, including variable environmental conditions, will be investigated as well.

The baseline seabird protection measures for longline vessels were developed in large part to protect short-tailed albatross but were based on the deterrence of northern fulmars and other albatross species since they behave in a similar manner around fishing vessels (see Appendix F-6 for a discussion of the effectiveness of the present seabird protection measures). Similarly, the new seabird protection measures that would be enacted under FMP 1 (68 FR 6386) were based in part on the substantial reduction of incidental take of fulmars and albatross using paired and single tori lines (Melvin *et al.* 2001). Although NOAA Fisheries is currently in the process of finalizing the new seabird deterrent regulations, many longline vessels have already adopted the paired and single tori line techniques on a voluntary basis and the numbers of birds taken per 1000 hooks has been decreasing since 2001. These new regulations are expected to result in a substantial overall reduction in take of fulmars, partly due to the effectiveness of the new techniques in deterring surface-feeding species and partly due to the inclusion of performance standards in the new regulations that were not included in the baseline. Since most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season, incidental take data from the 2002 season should give some indication of the potential effectiveness of the new regulations in reducing take of fulmars. Incidental take data are reported in the annual SAFE, Ecosystems Considerations Report. Data from the 2002 season will be available in the 2003 SAFE (NPFMC 2003b) (see Comment Analysis Report for updated statistics and analysis).

As described in the albatross section above, FMP 1 would incorporate any mitigation measures that arise from current research on incidental take from trawl third wires. Management actions under FMP 1 would therefore be expected to substantially reduce overall incidental take of fulmars relative to the baseline condition. Since the amount of incidental take for fulmars under the baseline conditions is considered to be insignificant at the population level, the reduced level of take under FMP 1 is therefore considered to be insignificant at the population level for fulmars.

Changes in Food Availability

Fulmars forage over vast areas of ocean on prey that are taken in very small amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections, 4.5.4 and 4.5.10). Fulmars are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 1. FMP 1 is therefore considered to have insignificant effects on fulmars.

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 1. FMP 1 is therefore considered to have no effects on this species.

Cumulative Effects of FMP 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 1 are described above (Table 4.5-55). 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 4.5-55.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the incidental take of fulmars in the groundfish fishery. Expected incidental take is considered insignificant at the population level.

- **Persistent Past Effects.** Fulmars have probably been taken incidentally in every net and longline fishery in the North Pacific but there are very little data on the magnitude of that overall mortality. Incidental take in the BSAI/GOA groundfish fisheries appears to be the largest source of human-caused mortality for fulmars in this area with an estimated average of over 15,000 birds per year from all gear sectors. Although fulmars are very abundant (estimated 2 million in the BSAI/GOA) and there is no indication of an area-wide population decline, there is some concern that particular colonies, especially on the Pribilof Islands, 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 Effects.** Incidental take of fulmars is expected to continue in all offshore fisheries in the BSAI/GOA. The IPHC fisheries will be subject to the same new seabird avoidance measures as the groundfish longline fleet 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 cannot be predicted.

- **Cumulative Effects.** Since the population of northern fulmars appears to be stable and the primary human-caused mortality factors, including contributions from the groundfish fisheries under FMP 1, are expected to decline in the future, the cumulative effects on fulmars are considered to be insignificant at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of forage fish and pelagic invertebrates as bycatch under FMP 1. 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 cannot 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, cannot 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 these species.

4.5.7.5 Species of Management Concern (Red-Legged Kittiwakes, Marbled and Kittlitz's Murrelets)

Direct/Indirect Effects of FMP 1

Incidental Take

The population of red-legged kittiwakes is estimated at around 150,000 birds, almost 80 percent of which nest on St. George Island in the Pribilofs. The combination of their restricted breeding area and substantial declines on permanent census plots led to their classification as a USFWS species of management concern. Red-legged kittiwakes have a separate species code in the Observer Program data on incidental take and may also be reported under the "gull" category and potentially under "unidentified seabirds" (Tables 3.7-1 through 3.7-5). Between 1993 and 2001, no specified red-legged kittiwakes were recorded as taken in the BSAI and GOA groundfish fisheries.

The proposed new seabird avoidance measures that would be adopted under FMP 1 are expected to substantially reduce the incidental take of surface-feeding seabirds such as red-legged kittiwakes. Since the incidental take of red-legged kittiwakes is apparently already very rare (if it occurs), a reduced level of take would be considered insignificant at the population level. The effects of FMP 1 on red-legged kittiwakes through incidental take are therefore considered insignificant.

Marbled and Kittlitz's murrelets are species of management concern in Alaska due to recent dramatic declines in their numbers in core habitats in southeast Alaska. Both of these species have separate species codes in the Observer Program data and may also be reported under the "alcids" and perhaps the "unidentified seabird" groups. No marbled or Kittlitz's murrelets have been specifically reported taken in the observed groundfish fisheries between 1993 and 2001 Tables 3.7-1 through 3.7-5). Given their nearshore preferences and non-gregarious behavior, it is unlikely that murrelets are taken regularly in any of the BSAI/GOA groundfish fisheries. Since alcids are taken so infrequently on longlines, seabird avoidance measures for longlines would likely not affect the incidental take of murrelets. Therefore, the effects of FMP 1 on marbled and Kittlitz's murrelets through incidental take are considered insignificant at the population level.

Changes in Food Availability

Red-legged kittiwakes consume several species of small schooling fish as well as zooplankton. Given the wide variety of foods used by kittiwakes and the extensive areas over which they forage, it seems unlikely that they are very susceptible to localized depletion of prey during the non-breeding season. However, while nesting, kittiwakes are more limited in their options and are more susceptible to localized depletions of prey around their colonies. The existing ban on the development of a commercial forage fish fishery would be maintained under FMP 1 and is considered to be beneficial to seabirds by preventing a potentially adverse fishery from developing. The species and size classes of forage fish and zooplankton that red-legged kittiwakes consume are taken only in negligible amounts by the groundfish fisheries. The abundance and distribution of these prey species do not appear to be affected on an ecosystem level by the groundfish harvest under the baseline conditions (see Sections 4.5.4 and 4.5.10). Since the structure and intensity of the fishery under FMP 1 would be very similar to the baseline condition, FMP 1 is considered to have insignificant effects on the availability of food for red-legged kittiwakes.

Marbled and Kittlitz's murrelets forage in shallow waters within 5 kilometers (km) of shore and feed on small fish such as capelin and Pacific sandlance as well as zooplankton and other invertebrates. The groundfish fisheries have very little spatial overlap with murrelet foraging areas and, as described above for kittiwakes, appear to have insignificant effects on the abundance and distribution of these prey species. Overall, the effects of FMP 1 on the availability of prey for murrelets would be considered insignificant.

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 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 1 as these take place further offshore. FMP 1 is therefore considered to have insignificant effects on marbled and Kittlitz's murrelets, and no effects on red-legged kittiwakes.

Cumulative Effects of FMP 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 1 are described above (Table 4.5-56). 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 4.5-56.

<u>Mortality</u>

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the incidental take of surface-feeding seabirds such as red-legged kittiwakes. Since the incidental take of red-legged kittiwakes is apparently already very rare (if it occurs), a reduced level of take would be considered insignificant at the population level. Murrelets would be much more likely to be taken in trawls than longlines but no takes of either species have been recorded by groundfish observers. Incidental take of murrelets is therefore considered 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 (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 Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns for red-legged kittiwakes focus on potential impacts around the Pribilof Islands during the nesting season since 80 percent of the population is concentrated in time and space. For this reason, the introduction of nest predators or a large oil spill could have significant effects on mortality. While these potentially catastrophic events could happen at any time, several laws and programs are in place to mitigate the likelihood of them occurring.

  For the murrelet species, human impacts in nearshore habitats from the GOA to southeast Alaska will likely have a much greater effect on their populations than offshore fisheries. The largest sources of human-caused mortality from the past, oil spills and incidental take in salmon and other State 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. Both murrelet species continue to decline in their core areas and are thus considered to have significantly adverse cumulative effects at the population level.

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 1. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant 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 cannot 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, cannot be made at this time.

- **Cumulative Effects.** While the groundfish fisheries are considered to have an insignificant effect on prey availability on their own, 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. Since this dynamic could conceivably be adverse or beneficial depending on different circumstances, the cumulative effect on prey availability is considered to be unknown for these three species.

Benthic Habitat

No cumulative effect is identified for red-legged kittiwakes because they 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. 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 not contribute to potential effects on benthic habitats important to murrelets the cumulative effect is considered insignificant.

4.5.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of FMP 1

Incidental Take

The incidental take of species considered in this piscivorous group is reported in the Observer Program data under the gull, alcid, and "other" categories, as well as an unknown number of the "unidentified seabird" category (Tables 3.7-1 through 3.7-5). The number of piscivores taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001 data since these measures were implemented in 1997. The estimated number of gulls taken in this period averaged 3,268 birds per year in the BSAI longline sector, 147 birds per year on GOA longlines, and 274 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for an estimated average take of 3,689 birds per year in the groundfish fishery. Even if a large proportion of the unidentified seabirds are gulls, this level of mortality is considered insignificant at the population level given the combined estimated abundance (2.5 million birds) of the different gull species in the BSAI and GOA (Table 3.7-21).

For the alcids, mortality from the groundfish fishery comes almost entirely from the trawl sector and averaged 259 birds per year (mean of low and high estimates) in the BSAI/GOA trawls. Given the estimated abundance of large alcids in these waters (approaching 20 million, Table 3.7-21), this level of mortality is considered insignificant at the population level. Incidental take of cormorants would be included in the "other" category, which approaches zero and is therefore considered an insignificant level of mortality at the population level.

The new seabird protection measures for the longline fleet that would be instituted under FMP 1 (68 FR 6386) would be expected to result in a substantial overall reduction in take of surface-feeding species such as gulls. This is a substantial management and fishery action and is considered an improvement relative to the baseline level of mortality. Since the amount of incidental take for gulls under the baseline conditions is considered to be insignificant at the population level, the reduced level of take under FMP 1 is therefore considered to be insignificant at the population level for gulls.

Changes in Food Availability

Food consumption by seabirds depends not only on forage stocks in their feeding areas, but also on the availability of these stocks to the birds. The availability of prey to piscivorous seabirds is affected by a number of oceanographic and biological factors (see Section 3.7.1) that may vary substantially over short time periods and distances. The question of whether the intensity and structure of the groundfish fishery under the baseline condition has adverse or beneficial effects on the availability of forage fish for seabirds has not been addressed through directed research. Many of the data gaps identified in Section 5.1.2.8 address this issue. Although there are very little empirical data on how a fishery might affect the availability of forage fish to seabirds, it is assumed that fishing (with trawl gear at least) could disrupt the movements and structure of forage fish schools such that they would be less available to seabirds, at least for a short period of time. Localized depletion or disruption of prey species around seabird colonies could be particularly detrimental during the chick-rearing period for breeding seabirds. However, most species can forage up to 40 km from their colonies during chick-rearing with a few species ranging to 100 km so any localized and short term disruptions of forage fish would have negligible effects at the population level. The existing ban on the development of a commercial forage fish fishery (BSAI/GOA FMP Amendments 36/39) is considered to be beneficial to seabirds by preventing a potentially adverse fishery from developing. This ban would be maintained under FMP 1. The species and size classes of forage fish (and zooplankton) that piscivorous seabirds feed on are taken only in negligible amounts by the groundfish fisheries. The abundance and distribution of seabird prey does not appear to be affected on an ecosystem level by the groundfish harvest (see Sections 4.5.4 and 4.5.10). The baseline condition of groundfish harvest is therefore considered to have insignificant effects on the availability of food for piscivorous seabirds.

The fisheries provide an artificial yet nutritious supplement to seabird diets in the form of processing waste and offal. No studies have been conducted in Alaska on whether this food source provides a significant benefit to the survival rate or reproductive success of any species on the population or colony level. It is likely that the value of this supplemental food varies over time and space, fluctuating with the availability of natural food supplies and seasonal nutritional needs. Whereas some birds may benefit from the food supply provided by offal and processing waste, such waste also acts as an attractant that may lead to increased incidental take in fishing gear. In addition, some species, such as the large gulls, tend to be more successful at competing for fish scraps at vessels and processors and may thus receive a greater nutritional boost than the smaller species. Since the large gulls are also nest predators of other species, especially kittiwakes and murres, the supplemental food from fishery wastes may be beneficial to some species and detrimental to others within this species group. Thus, this indirect effect of the fishery potentially has both beneficial and adverse effects on seabirds and the net benefit or liability is unknown.

Under FMP 1, the structure and intensity of the fishery would be similar to the baseline condition, which is considered to have an insignificant effect on piscivorous seabird populations. FMP 1 would also maintain the ban on development of a directed forage fish fishery. For these reasons, FMP 1 is considered to have insignificant effects on food availability for piscivorous species.

Benthic Habitat

Cormorants and alcids have diverse diets that include both small schooling fishes (capelin and sand lance) as well as demersal fish species and crustaceans. These birds are capable of diving from 40 m to over 100 m deep and are thus able to reach the ocean floor in many areas. Some species, such as cormorants and guillemots, usually forage in coastal waters during the breeding season, but other species forage well away from land. Bottom trawl gear has the greatest potential to indirectly affect these diving seabirds via physical changes to benthic habitat but pelagic trawls (to various extents), pot gear, and longline gear also contact the ocean floor. Trawling (and to a lesser extent other fishing gear disturbance) can reduce habitat complexity and productivity (NRC 2002). Specific effects of trawling on seabird prey species in the BSAI/GOA (through habitat change rather than by direct take) are poorly known (see Sections 3.6 and 5.1.2.7 on EFH for a discussion of research needed to address data gaps in benthic habitat changes due to trawling). However, none of the species in this group appears to have experienced consistent or widespread population declines so there is no indication that the carrying capacity of the environment has been decreased through changes to benthic habitat (or any other mechanism). Overall trawl effort in the BSAI/GOA under FMP 1 will remain very similar to the baseline condition. The effect of FMP 1 on piscivorous seabirds through potential changes in benthic habitat is therefore considered insignificant at the population level.

Cumulative Effects of FMP 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 1 are described above (Table 4.5-57). 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 4.5-57.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the incidental take of surface-feeding seabirds such as gulls but not of diving species such as alcids. Incidental take of all species in this group is considered insignificant at the population level under FMP 1.

- **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, 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 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, 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 these species 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.

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 1. 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. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations cannot 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, including the EVOS, 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 foreign squid and forage fish 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, cannot be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute to the dynamic interaction of natural and human-caused events that affect the availability of forage fish and invertebrate prey to seabirds. While this dynamic is only beginning to be explored with directed research, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 1, the cumulative effect on prey availability is considered insignificant at the population level for these species.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, have the potential to modify benthic habitats and have indirect effects on the food web of diving piscivorous species. The overall effects of FMP 1 on piscivorous seabirds through potential changes in benthic habitat are considered insignificant.

- **Persistent Past Effects.** Benthic habitats important to the diving species in this group, including the alcids and cormorants, 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.** The groundfish fisheries contribute to the many human-caused and natural factors that alter benthic habitats important to the food web of piscivorous seabirds. While there has been limited research on specific effects of benthic habitat disturbance on seabirds, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 1, the cumulative effect on benthic habitat is considered insignificant at the population level for these species.

4.5.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of FMP 1

Incidental Take

Leach's and fork-tailed storm-petrels are not identified to species in the Observer Program data but they do have an "unidentified storm-petrel" code and may be reported in the "unidentified tubenoses," "other," and "unidentified seabird" categories (Tables 3.7-1 through 3.7-5). The numbers of storm-petrels in these categories are unknown but likely to be small given their feeding behavior. Given the abundance of these species in the BSAI/GOA area, with a combined population estimate of over 10 million birds (Table 3.7-21), incidental take of storm-petrels under the baseline conditions is considered to be insignificant at the population level. Although some of the planktivorous auklets have individual species codes in the Observer Program data, they are reported in the "alcid" and "unidentified seabird" categories. It is unlikely that they are taken on longlines at all and probably constitute only a small fraction of the trawl take. Given their abundance in the BSAI/GOA, with a combined population of over 10 million birds (Table 3.7-21), incidental take of auklets under the baseline conditions is considered to be insignificant at the population level.

Another means of incidental take in the fishery is by birds striking the vessel or rigging. The Observer Program does not record vessel strikes on a systematic basis so data on the frequency or extent of such strikes are very limited (NPFMC 2003b). Crested auklets do not seem to strike fishing vessels very frequently but when they do, the incidents often involve large numbers of birds. According to preliminary analysis of the observer records of bird-strikes from 1993-2000, 1,305 crested auklets were involved in 7 recorded collisions. In one historical account, approximately 6,000 crested auklets were attracted to lights and collided with a fishing vessel near Kodiak Island during the winter of 1977 (Dick and Donaldson 1978). Storm-petrels are also prone to periodic collisions involving many birds (631 birds in 19 recorded incidents). Bird strikes are probably most numerous during the night and during storms or foggy conditions when bright deck lights are on, which can cause the birds to be disoriented. Given the sporadic nature of these collisions and the small numbers of birds involved relative to their overall populations, the effect of the fisheries on these species through vessel collisions is considered insignificant at the population level under the baseline conditions. Since fishing effort under FMP 1 would be similar to the baseline, the effect of FMP 1 on incidental take from vessel collisions is considered insignificant.

Changes in Food Availability

Storm-petrels are relatively small surface feeding seabirds that primarily target zooplankton and juvenile fish. The auklets feed on zooplankton (euphausiids), juvenile fish, and squid. The abundance and distribution of these prey species are affected by a number of oceanographic and biological factors (see Section 3.7.1) that may vary substantially over short time periods and distances. 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, large changes to pollock populations as a result of fishing could theoretically affect 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 (bottom-up factors) than predator/prey relationships (top-down factors) (see Section 4.5.10). Since the structure and intensity of the fisheries managed under FMP 1 would be similar to the baseline conditions, the effects of FMP 1 on the availability of prey are considered to be insignificant at the population level for planktivorous seabirds.

Benthic Habitat

Storm-petrel 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 1. FMP 1 is therefore considered to have no effects on these species.

Cumulative Effects of FMP 1

The past/present effects on the species in this group, including storm-petrels and most auklets, 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 under FMP 1 are described above (Table 4.5-58). 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.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the incidental take of surface-feeding seabirds such as storm-petrels but not of diving species such as auklets. However, it is likely that more birds of these species die from occasional vessel strikes than are taken in any groundfish fishing gear. Incidental take of all species in this group are considered insignificant at the population level under FMP 1.

- **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 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. 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.

Changes in Food Availability

- **Direct/Indirect Effects.** The influence of the groundfish fisheries on the abundance and distribution of zooplankton and juvenile fish is limited to indirect effects on the abundance of target fish that prey on the same things the seabirds eat. This potential influence 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 under FMP 1.

- **Persistent Past Effects.** Zooplankton and juvenile fish have been taken in very small amounts as bycatch in squid and forage fish fisheries but their influence on abundance is probably negligible compared to natural fluctuations. Commercial whaling in the early 1900s decimated the populations of several planktivorous whales that competed with seabirds for prey. This release from competitive pressure may have had long-term beneficial effects on planktivorous seabird populations.

- **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, cannot 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 effect is identified for these species.

4.5.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of FMP 1

Incidental Take

Spectacled eiders interact very little, if at all, with the groundfish fisheries because most of the habitat for this species is located in the northern Bering Sea or in inshore areas of northwest Alaska. Although spectacled eiders have an individual species code in the Observer Program manual, no spectacled eiders have been observed to be taken in any of the fisheries since data collection began in 1993. Thus the groundfish fisheries have no effect on spectacled eiders.

The winter distribution of Steller's eiders does include areas where groundfish fisheries occur although these birds prefer shallow, nearshore waters. There is some overlap between the fisheries and Steller's eider critical habitat in the northwestern portion of Kuskokwim Bay (Kuskokwim Shoals). Only two vessels fished this area in 2001, both over 200 ft LOA so there was 100 percent observer coverage. Steller's eiders have an individual species code in the Observer Program manual but no incidental takes have been documented since 1995 (Tables 3.7-1 through 3.7-5). Based on the very minimal overlap between the predicted fisheries under FMP 1 and these two eider species, FMP 1 is considered to have insignificant effects on the population level through incidental take.

<u>Changes in Food Availability</u>

The abundance of marine invertebrate species important to the spectacled and 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. The groundfish fisheries catch only negligible amounts of these species and are unlikely to affect their abundance or distribution through ecosystem level effects under the baseline conditions (see Section, 4.5.10). Since the fishery under FMP 1 is also predicted to have a minimal overlap with Steller's eider habitat, the effects of FMP 1 on prey abundance for Steller's eider species (separate from potential benthic habitat effects) are considered insignificant at the population level. As, discussed above, the groundfish fisheries do not overlap in space or time with spectacled eider critical habitat and therefore, have no effect on spectacled eider food availability.

<u>Benthic Habitat</u>

Gear impacts on benthic habitat used by spectacled and Steller's eiders would primarily be from bottom trawl gear although pelagic trawls and pot gear also make contact with the bottom and contribute to benthic disturbance. Trawling (and to a lesser extent other fishing gear disturbance) can reduce habitat complexity and productivity (NRC 2002). The effects of trawl gear on benthic habitat are discussed in the EFH sections of this document (Sections 3.6.4 and 4.5.6). Based on an analysis of the Observer Program data, no overlap occurred between spectacled eider critical habitat and the groundfish fishery under the baseline conditions. Since FMP 1 is predicted to have a similar structure and intensity as the baseline, there are no predicted effects on spectacled eider benthic habitat.

Since Steller's eiders forage almost exclusively in shallow waters inshore of the groundfish fisheries, their preferred winter habitats are not subject to groundfish fishing effort. During the breeding season, the overlap of bottom trawl fisheries and Steller's eider critical habitat is also very limited, involving only a few vessels in a limited area of Kuskokwim Bay (Kuskokwim Shoals, NPFMC 2003b). The effects of this small bottom trawl fishery on Steller's eider critical habitat have not been investigated but considering the limited fishing effort and large area of critical habitat that is not fished, it is unlikely that the changes in benthic habitat resulting from this fishery would affect Steller's eiders on a population level. During Section 7 consultations with NOAA Fisheries, USFWS also concluded that the fisheries were not likely to affect Steller's eiders (USFWS 1992). Under FMP 1, the Kuskokwim Bay fishery is expected to continue in approximately the same area and intensity as under the baseline conditions. The overall effect of FMP 1 on the benthic habitat of Steller's eider is therefore considered to be insignificant at the population level.

Cumulative Effects of FMP 1

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 under FMP 1 are described above (Table 4.5-59). 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.

Mortality

- **Direct/Indirect Effects.** Spectacled eiders do not overlap in time and space with the groundfish fisheries and are not expected to have any incidental take under FMP 1. Steller's eiders overlap with the fisheries to a limited extent but incidental take has been and is expected to continue to be very rare. Incidental take of Steller's eiders is therefore considered to be insignificant at the population level under FMP 1.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution, and lead shot poisoning on the nesting grounds. 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 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. Human-caused mortality of Steller's eider, including very rare incidental take in the groundfish fisheries, does not appear to account for the past population decline in Alaska. Since the population may have stabilized and known human-caused mortality is very low, the cumulative effects of mortality on Steller's eiders are considered insignificant at the population level.

Changes in Food Availability

The abundance of marine invertebrate species important to the spectacled and 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 Steller's eider prey, the groundfish fisheries have a minimal contribution to these potential effects. Therefore, an insignificant cumulative effect on prey availability is identified for Steller's eiders. There are no cumulative effects identified for spectacled eider food availability since there are no direct/indirect impacts from the groundfish fisheries.

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 FMP1, 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 1 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.

- **Reasonably Foreseeable Future 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.** While the groundfish fisheries are predicted to have little spatial overlap with eider habitat under FMP 1, 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 Steller's eiders are therefore considered to be unknown. There are no identified effects on spectacled eiders' benthic habitat because no direct/indirect impacts from the groundfish fisheries have been identified.

4.5.8 Marine Mammals Alternative 1 Analysis

4.5.8.1 Western Distinct Population Segment of Steller Sea Lions

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 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 to1999 (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. 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 alternative management regime. The estimated annual incidental take level of Steller sea lions under FMP 1 in all areas combined is expected to be less than ten based on expected catch in this alternative, or about one sea lion per 220,000 mt of groundfish harvested. Incidental bycatch frequencies in the BSAI, which are typically low, reflect locations where fishing effort was highest. In the Aleutian Islands and GOA, incidental takes are often within critical habitat, though in the Bering Sea such bycatch is farther off shore and along the continental shelf. Otherwise there seems to be no apparent "hot spot" of incidental catch disproportionate with fishing effort. Therefore, it is appropriate to estimate take ratios based on estimated catch. However, if these take rates differ between observed and unobserved vessels then these take estimates would be biased accordingly. These rates also reflect a prohibition of trawling within ten or 20 nm of 37 rookeries which likely reduces the potential for incidental take, particularly during the breeding season when females are on feeding trips within the critical habitat area.

Entanglement of Steller sea lions in derelict fishing gear or other materials seems to occur at frequencies that do not have significant effects on the population. From a sample of rookeries and haul-out sites in the Aleutian Islands in which 15,957 adults were observed, Loughlin *et al.* (1986) found only 11 (0.07 percent) entangled in marine debris, some of which was derelict fishing gear. Observations of sea lions at Marmot Island for several months during the same year observed two out of 2,200 adults (0.09 percent) entangled in marine debris. Between 1993 and1997, only one fishery-related stranding was reported from the range of the western population: a sea lion observed in August 1997 with troll gear in its mouth and down its throat (Angliss *et al.* 2001). Entanglement of sea lions in derelict fishing gear or other marine debris does not appear to present a significant threat to the population.

The Marine Mammal Protection Act (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 potential biological removal (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 1 at levels that are small (less than ten percent) relative to PBR and is therefore considered insignificant according to the criteria set for significance (Table 4.1-6).

<u>Fisheries Harvest of Prey Species</u>

Changes in the fishing mortality rates for Steller sea lion prey species were calculated using output from the multi-species management model which projected catch rates for the various alternatives. The estimated fishing mortality rates expected to occur under each alternative management regime were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining effects of the FMPs 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 FMP fishing mortality rates are shown in Table 4.5-61.

Under FMP 1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 22 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 as significant. It is worth noting that the harvest rate of pollock in the EBS was abnormally low in 2002. This low harvest rate was due to the high abundance of commercially sized pollock in the EBS which resulted in a large recommended ABC for this population. By definition, ABC is set annually at a level deemed to be biologically acceptable based on the status and dynamics of the population, environmental conditions, and other ecological factors (e.g., natural mortality). The baseline groundfish FMPs contain catch provisions referred to as OYs that limit the total amount of BSAI and GOA groundfish harvest. Unlike the ABC, which is applied to individual species or species groups, the OY limit applies to the entire complex of commercially important species as well as other species with lesser or no commercial importance in each management region. In 1981, the OY for total BSAI groundfish catch was set as a range from 1.4 to 2.0 million mt. In 2002, the recommended ABC for pollock in the EBS was greater than the OY and was therefore capped to stay within the OY range. Because the 2002 EBS pollock TAC was capped by the OY ceiling, F was lower than that deemed to be biologically acceptable. Therefore, in relative terms, subsequent increases in F expected to occur under FMP 1 for EBS pollock may not result in significantly adverse effects to predators in terms of the biomass of prey available, despite being categorized as such under the established significance criteria.

The fishing mortality rate of GOA pollock is expected to increase by an average of one percent relative to the comparative baseline over the next five years under FMP 1. This change in F is insignificant 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 condition. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 1 and therefore effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level.

Under FMP 1, BSAI and GOA Pacific cod fishing mortality rates are expected to increase by 20 percent and decrease by 17 percent, respectively. These combined changes are insignificant to Steller sea lions according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with a 60 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline 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 FMP 1 were determined to be insignificant to Steller sea lions.

The comparative baseline conditions include all Steller sea lion protection measures that were adopted in 2001 (NMFS 2001a). These include provisions to protect prey resources such as area closures, critical habitat harvest limits on prey species, gear and TAC restrictions, and a modified global harvest control rule to prohibit fishing when spawning biomass per recruit is reduced to 20% of the unfished level. With these controls, the combined harvest of prey was found to not jeopardize the continued existence of the western populations of Steller sea lions (NMFS 2001a). Harvest levels under FMP 1 would be similar to the 2002 baseline conditions and are thus considered insignificant to the western population of Steller sea lions.

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. The spatial/temporal measures in FMP 1 were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods that 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, but where 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, so that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to jeopardize the continued existence of the western population of Steller sea lions or appreciably reduce the likelihood of their survival and recovery in the wild (NMFS 2001b). Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under FMP 1 are determined to be insignificant to Steller sea lions according to the criteria established in Table 4.1-6.

Disturbance

With regard to disturbance are existing management measures minimize nearshore disturbance of Steller sea lions. In particular, the prohibition of vessel entry within 3 nm of major rookeries avoids intentional and unintentional hazing of hauled out sea lions or those aggregated near shore. A total of 3,250 square kilometer (km^2) around 36 sites is offered this protection.

What is not clear, however, is what circumstances might constitute disturbance elsewhere, such as in pelagic foraging areas. Vessel traffic, nets moving through the water column, or underwater sound production may all represent perturbations, which could affect foraging behavior, but few data exist to determine their relevance to Steller sea lions. The influence of trawl activities on Steller sea lion foraging success cannot be addressed directly with existing data. Foraging could potentially be affected not only by interactions between vessels and sea lions, but also as a function of changes in fish schooling behavior, distributions or densities in response to harvesting activities. In other words, disturbance to the prey base may be as relevant a consideration as disturbance to the predator itself.

For the purposes of this analysis, it is recognized that some level of prey disturbance may occur as a fisheries effect. The impact on marine mammals who prey on fish schools is a function of both the amount of fishing activity and its concentration in space and time, neither of which may be extreme enough under the status quo to represent population-level concerns. To the extent that the baseline condition imposes limits on fishing activities inside critical habitat, it is assumed some protection from these disturbance effects is currently provided. These protections occur as byproducts of other actions that either reduce fishing effort or create buffer zones to limit impacts on foraging. Also, they occur directly in the case of the 3 nm no entry zones around rookeries. With these measures in place, the baseline is consistent with the underlying goal of reducing disturbance effects. Whether the residual levels of disturbance represent significant effects on Steller sea lions cannot be determined with the data that are currently available.

However, anecdotal evidence suggests that fisheries/disturbance related events are unlikely to be of consequence to the Steller's population as a whole. For instance, vessel traffic and underwater sound production have long been features of the Bering Sea and GOA, at least over much of the twentieth century. Such circumstances have prevailed before, as well as after the decline of Steller sea lions, suggesting no obvious causal link. Steller sea lions also appear to be tolerant of at least some anthropogenic effects, recognizing their attraction to fish processing facilities and gillnets as well as their distributions in proximity to ports. Further, the eastern population of Steller sea lions is increasing, despite anthropogenic activities throughout their range on the west coast of North America and particularly in southeast Alaska. Levels of disturbance to Steller sea lions similar to those occurred in 2002 are expected under FMP 1. The effects of disturbance on Steller sea lions under FMP 1 are expected to be insignificant relative to the baseline.

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 and indirect effects of the groundfish fishery under FMP 1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. This analysis seeks to provide an overall assessment of the species' population-level response to its environment as it is influenced by the groundfish fishery. The effects considered in this analysis are listed in Table 4.5-62. 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).

<u>Mortality</u>

- **Direct/Indirect Effects.** Mortalities from incidental take and entanglement in derelict fishing gear occur at frequencies that do not have population-level effects on the western population of Steller sea lions and are therefore 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 to 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 population (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 to1998) (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. 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).

- **Reasonably Foreseeable Future External 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.** The cumulative effect of mortality based on the contribution of internal effects of the groundfish fishery and external mortality factors is considered significantly adverse for the western population of Steller sea lions. The western population of Steller sea lions has declined approximately 80 percent since the 1970s and was listed as endangered under the ESA in 1997. A number of human-caused mortality factors have been identified as potentially contributing to this decline and lack of recovery. According to current estimates, incidental take from the BSAI and GOA groundfish fisheries and other fisheries (29) and subsistence harvest (198) exceeds the PBR (208) for the western population of Steller sea lions (Angliss and Lodge 2002). In addition, natural mortality factors, such as predation by transient killer whales and sharks, may be relatively more important for a depressed population and may be inhibiting the recovery of the Steller sea lion population. Because the population is still depressed from historic levels, has not recovered to the point that a recovery rate can be reliably calculated, and overall human-caused mortality exceeds the PBR for this population, the cumulative effect of all mortality factors is considered significantly adverse for the western population of Steller sea lions. The contribution of the groundfish fisheries to mortality is small compared to total human-caused mortality, and as such, has been determined not to jeopardize the continued existence or recovery of the western population under the ESA (NMFS 2001b).

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of Steller sea lion prey species under FMP 1 is not expected to result in population-level effects and is rated as insignificant.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that were targeted or taken as bycatch by the foreign, JV, and domestic groundfish fisheries and parallel fisheries in state waters, and partial overlap with other state-managed 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. 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 Biological Opinions (BiOps) since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of the western population of Steller sea lions or causing adverse impacts to their critical habitat. A recent Steller sea lion 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 are difficult to predict. Climate induced change has been suspected in the decline of the western stock Steller sea lion.

- **Cumulative Effects.** The cumulative effect on prey availability for Steller sea lions is based on direct, indirect, and external effects on prey and is considered conditionally significant adverse. This rating is based on the adverse effects on prey availability in the past from foreign, JV, and domestic groundfish fisheries, the state-managed salmon and herring fisheries, and indications that prey availability has been a key factor in the decline of the western population over the last several decades. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine with natural fluctuations to affect prey availability such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under FMP 1 are determined to be insignificant to Steller sea lions.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, as well as state-managed fisheries for salmon and herring have all attempted to maximize their catch per unit effort by concentrating their fishing at times and places where fish are most concentrated. 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 caused localized depletion of forage fish. Past changes in the domestic groundfish harvest regulations have dispersed the fishing effort in time and space in order to minimize the potential for localized depletion of Steller sea lion prey. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures, which constitute the baseline condition.

- **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 as they have been in recent years. No new state or federal fisheries are anticipated at this time.

- **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 on Steller sea lions under FMP 1 are considered to be insignificant.

- **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 fishing gear have also regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future sources of disturbance were 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 low level disturbance to Steller sea lions. The level of disturbance is expected to be similar to baseline conditions.

- **Cumulative Effects.** The cumulative effect of disturbance to Steller sea lions is based on contributions from both internal and external events. This effect is considered insignificant, because the level of disturbance is similar to the baseline condition and population-level effects are unlikely.

4.5.8.2 Eastern Distinct Population Segment of Steller Sea Lions

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 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 that are either killed or sustain injuries that are expected to result in death. Because no animals from the eastern population have been taken incidental to groundfish fisheries, changes in catch resulting from the FMP 1 are not expected to result in an increase in the level of incidental takes.

Entanglement of Steller sea lions from the eastern population in derelict fishing gear or other marine debris seems to occur at frequencies that do not have significant effects upon the population. Entanglement of sea lions in derelict fishing gear or other marine debris does not appear to represent a significant threat to the population. In conclusion, incidental take and entanglement in marine debris under the FMP 1 are insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

BSAI groundfish fisheries are not likely to have large impacts on the prey availability of the eastern population of Steller sea lions as there is little overlap with 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 are expected to increase by one percent and decrease by 17 percent, respectively, relative to the comparative baseline over the next 5 years under FMP 1. The changes in the fishing mortality rates expected to occur under FMP 1 are insignificant at the population level for Steller sea lions.

Little difference is expected relative to the baseline 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 prey species for the eastern population of Steller sea lions under FMP 1 is not expected to result in population-level effects and was determined to be insignificant overall.

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. The spatial/temporal measures in FMP 1 (and retained throughout all of the alternative FMPs) were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods that are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, e.g., 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 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 eastern population of Steller sea lions in the wild. Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to the eastern population of Steller sea lions according to the criteria established in Table 4.1-6.

<u>Disturbance</u>

Levels of disturbance similar to those that occurred to the eastern population of Steller sea lions in 2002 are expected under the FMP 1 management regime. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on the eastern population of Steller sea lions under the FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

The past/present effects on the eastern population of the Steller sea lion in southeast Alaska are described in Section 3.8.1 (Table 3.8-1) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. The effects considered in this analysis are listed in Table 4.5-63. 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).

<u>Mortality</u>

- **Direct/Indirect Effects.** With regard to incidental take, FMP 1 is expected to have insignificant changes to the population trajectory of the eastern population of Steller sea lions (see Direct and Indirect Effect above).

- **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 involving illegal shooting of 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 from the eastern population is very small and is subject to an average of only two sea lions taken per year from southeast Alaska (1992-1997) (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). The proportion of these from the eastern population 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 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 gillnets 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 the closer association with human population centers. Climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** The cumulative effect of mortality based on the contribution of internal effects of the groundfish fishery and external mortality effects is considered insignificant because the overall human-caused mortality does not approach the PBR for this population. Although this population is listed as threatened under the ESA, the 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 not to cause jeopardy under the ESA (NMFS 2001b).

<u>Effects of Prey Availability</u>

- **Direct/Indirect Effects.** The combined harvest of the eastern population of Steller sea lion prey species under FMP 1 is not expected to result in population-level effects and is therefore determined to be insignificant.

- **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. 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. A recent Steller sea lion BiOp and EIS (NMFS 2001b and 2001c) explore 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 condition. 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 are 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.** The cumulative effects of prey availability on the eastern population of the Steller sea lion are considered to be insignificant at the population level. The eastern population of Steller sea lions has been increasing steadily over the last 20 years so prey availability is not considered to be limiting the recovery of the population.

<u>Spatial/Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in the FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under FMP 1 are determined to be insignificant 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 sea lion protective measures, which remain in effect under FMP 1.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon drift and set gillnet fisheries, salmon troll fisheries, and herring fisheries are expected to continue in future years in a generally similar manner to the baseline conditions.

- **Cumulative Effects.** The cumulative effect of spatial and temporal harvest of prey based on both internal and external sources is considered to be insignificant. This is because the effect is likely to remain similar to the baseline condition, under which the population has steadily increased.

<u>Disturbance</u>

- **Direct/Indirect Effects.** The effects of disturbance on Steller sea lions under the FMP 1 are expected to be similar to the baseline, and population-level effects are unlikely; therefore, internal effects are considered insignificant. Protection measures around rookeries and haulouts that limit the potential for disturbance will continue under FMP 1.

- **Persistent Past Effects.** Past disturbance was identified for foreign, JV, and domestic groundfish fisheries as well as state-managed salmon and herring fisheries. General vessel traffic has also contributed to the disturbance level for this population. Intentional shooting has likely been a factor in disturbance in past years.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and vessel traffic will likely continue in the future at a level similar to the baseline condition. Disturbance from subsistence harvest is not an issue for this population.

- **Cumulative Effects.** The cumulative effect of disturbance of prey based on both internal and external sources is considered to be insignificant. This is because the effect is likely to remain similar to the baseline condition, under which the population has increased steadily.

4.5.8.3 Northern Fur Seals

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, the FMP 1 is not likely to result in significant changes to the population trajectory of northern fur seals. The incidental take of northern fur seals is uncommon in the groundfish fisheries. The last recorded mortality in any Alaskan groundfish fishery occurred in 1996, when the take rate was one animal per 1,862,573 mt of groundfish harvested. Observer records from 1990 to 1999 indicate that direct interactions with groundfish vessels occurred only in the BSAI trawl fishery, despite observer placement in pot, longline and trawl fisheries in both the BSAI and GOA. In the BSAI trawl fishery, the average annual take rate (1995 to 1999) was 0.6. Since PBR for this population is 17,138 animals per year (Angliss and Lodge 2002), this level of take is inconsequential to population trends.

Northern fur seal entanglement in marine debris is more common than any other species of marine mammal in Alaskan waters (Laist 1987, 1997, Fowler 1987). Fowler (1987) concluded that mortality of northern fur seals from entanglement in marine debris contributed significantly to declining trends in the Pribilof Islands during mid to late 1970s and early 1980s. The contribution of intentional discard of net debris from Alaskan groundfish fisheries vessels is thought to have declined over the past decade. However, consistent numbers of seals entangled in packing bands on St. Paul Island may reflect disposal of these materials in proximity to the islands. Recent data from satellite-tracked drifters deployed in the Bering Sea suggests a "trapped" circulation pattern around the Pribilof Islands (Stabeno *et al.* 1999) which may retain marine debris in the nearshore environment. An increase in the number of Antarctic fur seals (*Arctocephalus gazella*) entangled in polypropylene packing bands was observed at Bird Island, South Georgia, in the late 1980s as these materials came into common usage by at-sea processing vessels (Croxall *et al.* 1990). Involuntary sources of marine debris, as in loss of gear, are diminishing as fishery cooperative systems develop (such as in the BSAI offshore pollock allocation). That is, as the pace of fisheries is slowed, there is less incentive to risk capital equipment. Data do not yet exist to assess the rates at which various gear types are lost or discarded to result in risk to fur seals, especially in regard to fishery or nation of origin. In consideration of progress in stemming the loss and discard of net fragments and other plastic debris by domestic commercial fisheries, the extent to which the current FMP could change the rate of fur seal entanglement in marine debris is considered to be low. There seem to be few options, given the likelihood that sources beyond the control of fisheries managers (i.e., foreign fisheries, international shipping, and shoreside refuse) constitute significant sources of discard. In view of these factors, the effects on northern fur seals under the FMP 1 are rated insignificant, with respect to incidental take and entanglement in marine debris.

Fisheries Harvest of Prey Species

The diet of northern fur seals includes a wide range of fish species, with less apparent dependence on Pacific cod and Atka mackerel compared to Steller sea lions. However, both adult and juvenile pollock occur in the diet of northern fur seals and consumption rates vary according to the abundance of different age classes of pollock in the foraging environment (Swartzman and Haar 1983; Sinclair *et al.* 1996). Because fur seals are opportunistic foragers, the presence of strong year-classes results in a disproportionately high percentage of that age class of pollock in the fur seal diet. Evaluation of the effects of harvest of prey species on northern fur seals, focuses less on removals of Pacific cod and Atka mackerel and more broadly on removals of pollock and small schooling fishes. Northern fur seals forage at shallow to mid-water depths of 0 to 820 ft (0-250 m), both near shore and in pelagic regions of their migratory range. Female and young male fur seals generally consume both juvenile and adult small-sized (2 to 8 inches) schooling fishes and squids although diet varies across oceanographic subregions along their migration routes and around breeding locations in the Pribilof Islands. In the eastern Bering Sea, primary prey species include pollock and Pacific cod, but deep sea smelts, lanternfish, and squids are also major components. Studies based on scat analysis have indicated that the pollock and Pacific cod consumed by fur seals tend to be smaller than those selected by the target fisheries, however data from stomach collections from the 1960s through the 1980s indicate that fur seals often consume adult pollock. Recent studies using bio-chemical methods to study the diet of northern fur seals suggests that the diet of deep diving fur seals in waters over the continental shelf includes adult pollock (Kurle and Worthy 2000, Goebel 2002).

Under the FMP 1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 22 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of adult pollock , which is a key prey species of northern fur seals in the EBS, is rated significantly adverse. However, overall harvest of northern fur seal prey species is considered insignificant under the FMP 1 due to the factors explained below.

Catches of squid and small schooling fish (e.g., fish designated in the forage fish assemblage) in the groundfish fisheries of the BSAI and GOA are low, generally less than 1,000 mt per year. While precise biomass estimates for these groups do not exist, the exploitation rate on these groups in the groundfish fisheries is thought to be very low. For instance, squid biomass in the Bering Sea may be as large as 4 million mt, based on marine mammal food habits, daily ration, and abundance data (Sobolevsky 1996). Similarly, with respect to small schooling fishes, consumption of capelin in the GOA by arrowtooth flounder alone may be as large as 300,000 mt per year (Livingston 1994). Assuming that these crude projections of squid and capelin biomass at least approximate the order of magnitude of the true population levels, then the fisheries removals would amount to only a fraction of one percent of those populations. Fisheries for pollock and Pacific cod do not target fish younger than 3 years of age (Ianelli *et al.* 1999, Dorn *et al.* 1999, Thompson and Dorn 1999, Thompson and Zenger 1994, Fritz 1996). Catches of pollock smaller than 30 centimeters (cm) are small, and thought to be only 1 to 4 percent of the number of one- and two-year olds each year in the EBS and GOA (Fritz 1996).

Therefore, while fisheries do harvest prey of northern fur seals (i.e. pollock and Pacific cod), competition due to the harvest rates of those species may vary depending on the size range consumed by northern fur seals. The overall catch of juvenile pollock has tended to be low in recent years and the degree to which adult pollock occur in the northern fur seal diet is not certain. While the potential overlap with fisheries may be moderated by these factors, effects on northern fur seals may yet exist, the relevance of which is not reflected by estimates of biomass removals over large geographical areas.

The potential for competitive overlap between northern fur seals and groundfish fisheries may be tempered by the spatial and temporal distribution of the harvest. These effects are analyzed under the "Spatial/Temporal" heading. Fisheries may also trigger trophic level effects which may affect the availability of northern fur seal prey and these effects are discussed in the ecosystem section.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures in the FMP 1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to northern fur seals according to the criteria established in Table 4.1-6. 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 changes in the spatial/temporal effects of FMP 1 are insignificant relative to the baseline, the baseline has been described as having potential adverse effects on northern fur seals based on past concentration of the fisheries.

In recent years, fishing effort for pollock has increased in nearshore areas around the Pribilof Islands (NMFS 2003) where northern fur seals are known to forage. The greatest potential for temporal overlap between northern fur seals and the pollock fishery in the eastern Bering sea is July through November. Under the baseline, pollock fisheries were extended in order to slow the pace of the fishery and now occur from June through October. This disperses the harvest over a longer time period than in previous seasons, thereby reducing temporal concentration of the fisheries. However, this change also extends the fisheries into the summer months when fur seals are concentrated near the Pribilof Island rookeries and may thus increase the likelihood of localized effects in foraging areas near the Pribilofs (NMFS 2001b). Seasonally, the highest bycatch of small pollock occurs during the summer (May-July) when spawning aggregations have dispersed and pollock are generally less segregated by size (Fritz 1996). However, given the expected temporal dispersal of the fisheries under FMP 1 and the steadily increasing biomass trends for pollock, the magnitude of harvest and bycatch of species/size classes important to fur seals during the breeding season is not expected to cause localized depletion of prey to the point that the fur seal population as a whole will be affected. Therefore, the spatial/temporal concentration of the fishery under FMP 1 is determined to be insignificant to northern fur seals.

Disturbance

Disturbance from the baseline level of fishing activities has not been implicated as a potential cause for the population decline of northern fur seals. FMP 1 is expected to produce similar levels of disturbance as the baseline which are unlikely to have population-level effects and are therefore considered insignificant according to the significance criteria established in Table 4.1-6.

Cumulative Effects

A summary of the past/present effects on the northern fur seal are described in Section 3.8.2 (Table 3.8-2), and the predicted direct and indirect effects of the groundfish fishery under FMP1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. This analysis seeks to provide an overall assessment of the species' population-level response to its environment as it is influenced by the groundfish fishery. The effects considered in this analysis are listed in Table 4.5-64. 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.** With respect to mortality and entanglement in marine debris, the effects on the northern fur seal under the FMP 1are rated as 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 is uncertain since it has been nearly 20 years since commercial harvest was ended. Subsistence harvests 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 U.S. EEZ where fur seal are widely dispersed. State-managed fisheries take small numbers of fur seal including 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. Levels of take are expected to be well below 10 percent of the PBR for this species. Short-term and long-term climate change is not considered a major mortality factor for this species.

- **Cumulative Effects.** The cumulative effect of mortality from internal and external factors is considered insignificant. The contribution of the groundfish fisheries is very small and approaches zero. The cumulative effect is considered insignificant because of the size of the fur seal population in relation to existing levels of take, which are well below the PBR of this species; therefore, population-level effects are not anticipated.

Availability of Prey

- **Direct/Indirect Effects.** The effect of the groundfish fisheries under the FMP 1 is not expected to have population-level effects, therefore, is rated as insignificant to northern fur seal (see Direct and Indirect Effect above.

- **Persistent Past Effects.** Effect of groundfish harvest in the past has 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.** Effect on prey availability for northern fur seal in the futures is considered to come from a small overlap in prey species with the state-managed salmon and herring fisheries in nearshore areas and effect 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 Effects.** The effects of groundfish fisheries under FMP 1 on the spatial/temporal concentration of fisheries harvest are very similar to the baseline conditions; thus, the effects of the spatial/temporal concentration under FMP 1 are determined to be insignificant to northern fur seals.

- **Persistent Past Effect.** Effect of past fisheries harvest of prey are primarily from the foreign and JV fisheries and the state and domestic fisheries in the BSAI. There has been concern with regard to displaced/increased fishing effort that is encroaching into nearshore areas of the Pribilofs resulting in increased overlap with fur seal foraging areas. 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 that this increased fishing pressure could have impacted 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 are primarily from the foreign and domestic fisheries outside the EEZ, due to the extensive range of the fur seal 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 effect of the spatial/temporal harvest of prey based on the presence of internal and external factors 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 localized depletion of prey is a plausible mechanism that could have contributed to the decline. The potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional because the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established.

Disturbance

- **Direct/Indirect Effects.** FMP 1 is expected to produce similar levels of disturbance as the baseline, and as such, these effects are unlikely to have population-level effects and are therefore considered insignificant at the population level.

- **Persistent Past Effects.** Past disturbance of fur seals includes commercial groundfish fisheries harvest by foreign, JV, and domestic groundfish 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.

- **Reasonably Foreseeable Future External Effects.** Future external disturbance effects on fur seal were identified for state-managed fisheries and subsistence activities on the Pribilof Islands. No new fisheries are expected within the range of the northern fur seal.

- **Cumulative Effects.** The cumulative effect of disturbance from internal and external factors is considered insignificant because there is little evidence to indicate an adverse effect at the population level for this degree of disturbance.

4.5.8.4 Harbor Seals

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

In both the GOA and BSAI, groundfish fisheries takes of harbor seals are at levels approaching zero and are insignificant factors in population trends. Reported cases of harbor seal entanglement in marine debris are less prevalent than for northern fur seals or Steller sea lions (Laist 1987, 1997). Given their inshore distribution and the high frequency with which they are observed, the low incidence of entanglement is unlikely to be a result of few opportunities to document such events. Thus, the effect of direct take and entanglement in marine debris under FMP 1 on harbor seal populations is rated insignificant.

Fisheries Harvest of Prey Species

The major prey of harbor seals in Alaskan waters include fish from the following families: Gadidae, Clupeidae, Cottidae, Pleuronectidae, Salmonidae, Osmeridae, Hexagrammidae, and Trichodontidae. Octopus and gonatid squid are also important. However, overlaps with commercial groundfish fisheries occur primarily with reference to pollock, Atka mackerel, and Pacific cod, which may constitute grounds for indirect interactions, particularly in the GOA and Aleutian Islands. However, the basis for concern is less pronounced than those noted for Steller sea lions, or even for northern fur seals, so that the overall effects are likely to be lower as well. Pollock, Atka mackerel, and Pacific cod constitute approximately 12, 9, and 8 percent, respectively, of harbor seal diet in the Aleutian Islands and Bering Sea (Perez 1990). In the GOA, pollock, octopus and capelin were reported by Pitcher and Calkins (1979) as the most important prey, while Pacific cod was less important and Atka mackerel were absent in the sample. Ashwell-Erickson and Elsner (1981) estimated that harbor seals and spotted seals combined consume approximately 81,600 mt of pollock per year, compared to current Bering Sea pollock biomass estimates (1998) of over 9 million mt. Pollock removals by fisheries are less than 10 percent of the biomass estimate, suggesting that in terms of volume, the unharvested fraction is sufficient to satisfy harbor seal foraging needs. Under FMP 1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 22 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 significantly adverse. See the discussion regarding the aberrant fishing mortality rate for EBS pollock in 2002 (which served as the comparative baseline) in Section 4.5.9.1.

The fishing mortality rate of GOA pollock is expected to increase by an average of one percent relative to the comparative baseline over the next 5 years under the FMP 1. This change in F is insignificant at the population level for harbor seals. Under the FMP 1, the BSAI Pacific cod fishing mortality rates is expected to increase by 20 percent which was determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to harbor seals with a 60 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 FMP 1 was determined to be insignificant to harbor seals. Although there is overlap in species/size classes taken by the groundfish fisheries and harbor seal prey, harbor seals also consume a large amount of other prey species. The combined harvest of harbor seal prey species under FMP 1 is not expected to increase substantially from the baseline condition or to result in population-level effects and was determined to be insignificant overall.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6.

Disturbance

The potential for disturbance effects caused by vessel traffic, fishing gear, or noise appears limited for harbor seals. These animals are common in nearshore waters and are subjected to considerable levels of anthropogenic disturbances, typical of ports and shipping lanes. Interactions with groundfish fishing gear, such as trawl nets, also appears limited, based on the rare incidence of takes in groundfish fisheries. Finally, given the nearshore distribution of harbor seals, their overlap with fishing activities is more limited than in the case of either Steller sea lion or northern fur seals. FMP 1 is expected to produce similar levels of disturbance as the baseline which are unlikely to have population-level effects and are therefore considered insignificant according to the significance criteria established in Table 4.1-6.

Cumulative Effects

A summary of the past and present effects with regards to harbor seals is presented in Section 3.8.4. (Table 3.8-4). The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.5-65). 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.** In both the GOA and BSAI, groundfish fisheries' takes of harbor seals are at levels approaching zero and do not likely affect population trends. Thus, the effect of incidental take and entanglement in marine debris under FMP 1 is rated as insignificant at the population level.

- **Persistent Past Effects.** 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 is 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 less than 1 per year in the GOA. In southeast Alaska, 4 harbor 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 harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which are taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). 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 seals in state-managed fisheries such as salmon set and drift 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 seals although there would likely be indirect effects.

- **Cumulative Effects.** The cumulative effect of mortality from both the internal contribution of the groundfish fisheries and external factors is considered insignificant. The human-caused mortality for all harbor seals is below the PBR for each stock and, therefore, population-level effects are unlikely.

Availability of Prey

- **Direct/Indirect Effects.** The combined harvest of harbor seal prey species under FMP1 is not expected to result in population-level effects and was determined to be insignificant overall.

- **Persistent Past Effects.** Availability of prey for harbor seals in the past has likely been affected by foreign, JV, and 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, especially in preferred nearshore foraging areas. Climate change/regime shift will continue 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 of prey availability from internal effects of the groundfish fisheries and external factors is considered conditionally significant adverse. This rating is based on the fact that the population has 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 harbor seals through this mechanism are considered conditional.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to harbor seals.

- **Persistent Past Effects.** Effects of prey 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. Climate and oceanic fluctuations are not considered factors in past changes in the spatial/temporal harvest of harbor seal prey.

- **Reasonably Foreseeable Future External Effects.** Future effects on spatial/temporal harvest is considered for the state-managed fisheries in nearshore areas such as salmon and herring. Since these fisheries generally occur in the nearshore areas in comparison to groundfish fisheries, overlap is more pronounced than with the groundfish fisheries. Effects of climate change/regime shifts on prey species abundance and distribution are also likely in the foreseeable future.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey from internal effects of the groundfish fisheries and external effects of other fisheries is considered to be conditionally significant adverse. This rating is based on the fact that the population has 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. The potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional because the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance similar to those that occurred to harbor seals under the baseline conditions are expected under the FMP 1. The effects of disturbance on harbor seals are considered to be insignificant at the population level.

- **Persistent Past Effects.** Disturbance of harbor seals in the past include commercial groundfish fisheries harvest by foreign, JV, and domestic fisheries, commercial harvest, state predator control programs, 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 continue to result in some level of disturbance to harbor seals.

- **Reasonably Foreseeable Future Effects.** State-managed fisheries, general vessel traffic, and subsistence activities would be expected to continue to create some level of disturbance to harbor seals in the foreseeable future.

- **Cumulative Effects.** The cumulative effect of disturbance from internal and external sources is considered to be insignificant. Harbor seals have been exposed to similar levels of disturbance for many years and there is little to indicate an adverse effect of this level of disturbance on the population-level.

4.5.8.5 Other Pinnipeds

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

The incidental take rates in commercial fisheries for ice seals, walrus and northern elephant seals are very low. Mean annual mortality of all ice seals combined from 1995 - 1999 was estimated to be 1.8 animals based on NMFS observers on board BSAI groundfish trawl, longline, and pot fishing vessels (Angliss *et al.* 2001) (Table 4.5-60). These rates constitute levels approaching zero according to NMFS standards (Angliss *et al.* 2001) and are not expected to affect the population trajectories of the species included in this category. The take rate of walrus and elephant seal qualifies as an insignificant level, approaching zero by NMFS standards (Forney *et al.* 2000) and is not expected to affect population trajectory of these species. Entanglement in marine debris is likewise rare for these species and is considered to have insignificant effects. Of the federally-managed fisheries in Alaska, only the EBS and Aleutian Islands pollock fishery would be likely to have an impact on ice seals and walrus, because of their northern distribution in the Bering Sea. Because of their distribution in the GOA and south of the Aleutian Islands (Stewart and DeLong 1994, LeBoeuf *et al.* 2000), northern elephant seals would be likely to be affected only by the GOA and Aleutian Islands pollock and cod fisheries. Population-level effects are not expected to result from incidental take and entanglement under FMP 1. Therefore, incidental take and entanglement of other pinnipeds under FMP 1 is rated insignificant.

Fisheries Harvest of Prey Species

With the exception of spotted seals, the food habits of the ice seals do not overlap with commercial fisheries targets. Bearded seals consume primarily benthic prey including crabs and clams as well as shrimps and Arctic cod (Kosygin 1966, 1971, Lowry 1981a, 1981b). Ringed seals eat Arctic cod, saffron cod, smelt, herring, shrimps, amphipods and euphausiids (Fedoseev 1984, Johnson *et al.* 1966, Lowry *et al.* 1980, McLaren 1958). Ribbon seal diet has been characterized as intermediate between ringed and bearded seals (Shustov 1965). Spotted seals include pollock in their diet when feeding in the central Bering Sea (Bukhtiyarov *et al.* 1984), but their use of that resource in the EBS and Aleutian Islands is unknown. Spotted seal diet in Bristol Bay, the Priblof Islands and the eastern Aleutian Islands is likewise unknown, but if similar to harbor seals in those areas, it is likely to be diverse and may include a small percentage of commercially important species. Thus, no effects on ice seals are assumed to occur under the baseline, nor are they likely to occur under FMP 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 under FMP 1 would have insignificant effects 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 is determined to be unknown under FMP 1.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures in the FMP 1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to other pinnipeds according to the criteria established in Table 4.1-6.

Disturbance

Levels of disturbance similar to those that occurred to other pinnipeds under the baseline are expected under the FMP 1 management regime. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on other pinnipeds under FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

A summary of the past/present effects on other pinnipeds is presented in Section 3.8.2 and Section 3.8.5 to Section 3.8.9. (Tables 3.8-3 through 3.8-9). The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. Cumulative effects are summarized in Table 4.5-66.

Mortality

- **Direct/Indirect Effects.** Population-level effects are not expected to result from incidental take and entanglement under FMP 1 and are rated as insignificant.

- **Persistent Past Effects.** Past external effects on the populations of pinnipeds 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 and Lodge 2002). 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 reported 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 with one reported taken in 1990, one in 1991, and one in 1997. An average of 86 elephant seals are taken each year in various gillnet fisheries from California to Washington.

Incidental take included one in the Bering Sea trawl fishery 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 eastern Bering Sea between 1990 and 1997, over 80 percent were already decomposed (Gorbics *et al.* 1998). Subsistence is the major human-caused external factor for mortality. Annual subsistence 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.** The cumulative effect of mortality within the other pinniped group from both internal effects of the groundfish fisheries and external effects such as subsistence harvest is considered insignificant. 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.

Availability of Prey

- **Direct/Indirect Effects.** 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 the FMP 1.

- **Persistent Past Effects.** Past effects on spotted seal prey include foreign, JV, and domestic groundfish fisheries, as well as state-managed fisheries for salmon and herring. For the other 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 were identified for state-managed fisheries for the spotted seal. Climate change may be either a beneficial or adverse factor for pinnipeds due to the potential effects of ice cover on their foraging strategies and the abundance and distribution of prey in the Bering Sea.

- **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.** Spatial and temporal fishing measures in the FMP 1 do not deviate from the baseline, and therefore have an insignificant effect on pinniped species.

- **Persistent Past Effects.** Persistent past effects on spotted seal include foreign, JV, and domestic groundfish fisheries, as well as state-managed fisheries. For other species, none are identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries within the range of spotted seals 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 other species in this group 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 seasonal overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects.** Similar levels of disturbance as the baseline are expected under the FMP 1 and are considered insignificant.

- **Persistent Past Effects.** Past sources of disturbance of spotted seals have been identified from the foreign, JV, and the domestic groundfish fisheries in the BSAI and state-managed fisheries for salmon. Overlap of fisheries is minimal for most species in this group. The primary source of external disturbance to the other pinniped category would be related to subsistence harvest.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries could be expected to continue at a level similar to the baseline condition. Disturbance from subsistence harvest activities in future years would be expected to be similar to the baseline conditions.

- **Cumulative Effects.** The cumulative effect of disturbance from internal and external effects is found to be insignificant for all species based on very limited overlap with the fisheries and the lack of evidence that disturbance has a population-level effect for any of these species.

4.5.8.6 Transient Killer Whales

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 1 is not likely to result in significant changes to the population trajectory of killer whales. Six commercial fisheries in Alaska that could have interacted with transient killer whales from the western and GOA stock were monitored for incidental take by fishery observers from 1990 to 1999. Of the observed fisheries (BSAI and GOA groundfish trawl, pot, and longline), killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Angliss *et al.* 2001) (Table 4.5-60).

In addition to mortalities caused by entanglement, killer whales are 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 mean annual mortality of killer whales incidental to groundfish fisheries from 1995 to 1999 was estimated to be 1.4 whales (Angliss *et al.* 2001). It is not known what proportion of these whales were transients versus residents. Interactions which result in the entanglement of killer whales in fishing gear are rare and are not expected to have population-level effects. The effects of entanglement and take of killer whales incidental to groundfish fisheries are rated insignificant.

Fisheries Harvest of Prey Species

The diet of transient killer whales consists of marine mammals. Because 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 under FMP 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 1.

Disturbance

Similar levels of disturbance as that which occurred to killer whales under the baseline are expected under FMP 1. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on killer whales under FMP 1 are expected to be insignificant relative to the baseline.

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 and indirect effects of the groundfish fishery under the FMP 1 are described above. This analysis seeks to provide an overall assessment of the species' population-level response to its environment as it is influenced by the groundfish fishery. The effects considered in this analysis are listed in Table 4.5-67. Representative direct effects used in this analysis include mortality and disturbance, with the major indirect effects of prey availability and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take, FMP 1 is not likely to result in significant changes to the population trajectory of transient killer whales.

- **Persistent Past Effects.** Mortality has been documented in the JV fisheries, domestic groundfish fisheries, state-managed fisheries, as well as reported intentional shootings. Past incidental take in the groundfish fisheries is less than 2 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. The EVOS resulted in the loss of half of the individual killer whales from the AT1 transient group in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and 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 (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future mortality is expected from external factors such as state-managed fisheries, intentional shooting, and marine pollution, particularly bio-accumulating compounds such as *para*-dichlorodephenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) (Matkin *et al.* 2001).

- **Cumulative Effects.** The cumulative effect of mortality from internal effects of the groundfish fisheries and other external factors is unlikely to have population-level effects on transient killer whales and is therefore determined to be insignificant. The exception to this finding is the AT1 transient group in PWS. The cumulative effect of mortality was determined to be significant adverse on the AT1 group due to the past external effects of the EVOS and subsequent population decline.

Prey Availability

- **Direct/Indirect Effects.** Because 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.** Because 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 due to 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 likely include foreign and state-managed fisheries, subsistence harvest, marine pollution, climate change, and regime shifts.

- **Cumulative Effects.** The cumulative effects of prey availability on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may focus on particular prey species, the ability of these top predators to vary their prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey in the diet of these mammals. The overall availability of prey does not appear to currently have 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. Because transient killer whales are able to vary 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 transient killer whales are expected to be similar to baseline conditions and are therefore expected to be insignificant.

- **Persistent Past Effects.** Some levels of disturbance have likely occurred 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 is 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.** The cumulative effect of internal and external disturbance factors is unlikely to have any population-level effect on transient killer whales and is therefore considered insignificant.

4.5.8.7 Other Toothed Whales

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 1 is not likely to result in significant changes to the population trajectories of toothed whales. 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. The highest incidental take rate for any cetacean is that of Dall's porpoise. From 1995 to 1999 an average of 8.8 Dall's porpoise were estimated to have been taken incidental to groundfish fishing activities. The majority of these were taken in BSAI trawl fisheries while an average of 1.6 and 1.2 animals were taken in BSAI longline and

GOA trawl fisheries, respectively. Three harbor porpoise moralities were observed incidental to BSAI groundfish trawl fisheries from 1995 to 1998. The mean annual mortality of Pacific white-sided dolphins incidental to groundfish fisheries from 1995 to 1999 was estimated to be less than one animal with reported takes occurring only in the BSAI longline fishery (Angliss *et al.* 2001) (Table 4.5-60). The estimated mean annual mortality of beluga whales, endangered sperm whales, and beaked whales incidental to groundfish fisheries was zero from 1995 to 1999.

Ten non-lethal interactions with endangered sperm whales have been documented in the GOA longline fishery targeting sablefish in management zones 640 and 650 (Hill *et al.* 1999). Two of the three entanglements reported between 1997 and 2000 resulted in release of the animal without serious injury. The extent of the injuries to the third animal was not known though it was alive at the time of release. No sperm whale mortalities have been observed or reported in the BSAI/GOA groundfish fisheries since observers began collecting data in 1990 (Angliss and Lodge 2002).

In the observed fisheries (BSAI and GOA groundfish trawl, pot, and longline), killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Angliss *et al.* 2001). The mean annual mortality of killer whales incidental to groundfish fisheries from 1995 to 1999 was estimated to be 1.4 whales (Angliss *et al.* 2001). It is not known what proportion of these whales were transients versus residents. Interactions which result in the entanglement of killer whales in fishing gear are rare and are not expected to have population-level effects.

The level of incidental takes and entanglement of these toothed whale species related to groundfish fishing activities is rare and is not expected to affect the population trajectories of any species, and is therefore insignificant at the population level.

Fisheries Harvest of Prey Species

The effects of the fisheries on toothed whale prey are largely constrained by differences between their prey and the fisheries harvest targets. FMP 1 is not expected to increase the level of competitive interactions for prey from the baseline condition and are therefore determined to be insignificant.

The beluga whale stocks along the western coast of Alaska from Bristol Bay north, and in Cook Inlet are generally restricted to shallow coastal and estuarian habitats not used by commercial groundfish fisheries. Their diet is predominantly salmonids and small schooling fishes such as eulachon and capelin. These species are taken only in small quantities as bycatch in the groundfish fisheries. Thus, it is unlikely that fishery interactions exist between beluga whales and Alaskan groundfish fisheries.

Similarly, Pacific white-sided dolphins are not commonly observed north of the Aleutian Islands, and appear to be seasonal visitors in parts of the GOA and southeast Alaska. The main body of their population is more commonly found in the central North Pacific Ocean (Ferrero and Walker 1996). With regard to diet, Pacific white-sided dolphins and Dall's porpoise feed mainly on cephalopods and small schooling fishes such as myctophids. These species are taken only in small quantities as bycatch in the groundfish fisheries.

The remaining species consume a wide variety of both fish and invertebrate species, but overlap with commercially important species is limited in most cases. Beaked whales, a diverse group unto itself, are poorly known, but available information suggests that they prey on benthic and epibenthic species including squid, skates, rattails, rockfish, and octopus. The diet of harbor porpoises in Alaskan waters is also poorly understood, although forage consumed by stocks in the Pacific Northwest and their tendency toward near shore distribution suggest that they probably consume a variety of coastal species. None of these species are taken in significant quantities in the groundfish fisheries.

Sperm whale diet overlaps with commercial fisheries targets more than any other species in this group, but the degree of overlap is at least partly due to direct interactions with longline gear. In addition to consuming primarily medium to large sized squids, they also consume salmonids, rockfish, lingcod and skates, and in the GOA they have been observed feeding off longline gear targeting sablefish and halibut. The interaction with commercial longline gear does not appear to have an adverse impact on sperm whales since no mortalities have been observed. However, the whales appear to have become more attracted to these vessels in recent years as reliable and easy sources of food.

Most information regarding resident killer whale's consumption of commercially important groundfish results from observations of whales depredating longlines as they are retrieved in locations ranging from the southeastern Bering Sea to PWS. In the waters between Unimak Pass and the Priblof Islands, killer whales regularly strip sablefish and Greenland turbot from longlines. Consumption of other groundfish species by resident killer whales not interacting with gear is largely unknown. In general, they are opportunistic feeders with diets that differ both regionally and seasonally. Nishiwaki and Handa (1958) examined killer whale stomach contents from the North Pacific and found squid, fish, and marine mammals. The importance of these prey items in the BSAI or GOA groundfish management areas is uncertain, but there is no evidence to suggest exclusive reliance on commercially important groundfish species.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures under FMP 1 do not deviate from the baseline, which do not appear to be causing localized depletion of prey for any species of toothed whale, and are thus determined to be insignificant to other toothed whales according to the criteria established in Table 4.1-6.

Disturbance

Similar levels of disturbance to toothed whales are expected under the FMP 1 as occurred under baseline conditions, which do not appear to have population-level effects on any species. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on toothed whales under the FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

The past/present effects on the other toothed whale species are described in Section 3.8.19 through 3.8-21 and Sections 3.8-23 through 3.8.25 (Tables 3.8-19 through 3.8-21 and Tables 3.8-23 through 3.8-25) and the predicted direct and indirect effects of the groundfish fishery under the FMP 1 are described above. The effects considered in this analysis are listed in Table 4.5-68. 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.** The level of mortality for toothed whale species related to groundfish fishing activities is rare and is not expected to affect the population trajectories of any of these species, and is therefore insignificant at the population level.

- **Persistent Past Effects.** Persistent past effects on species within the other toothed whale group include incidental take and entanglement in foreign, JV, and 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 been the result of 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 the Native Village of Tyonek and one beluga was harvested 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. One beluga was reported to be taken from the eastern Bering 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 longer occurs (Angliss *et al.* 2001). One Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery during the same time span (Angliss *et al.* 2001). State-managed salmon gillnet fisheries take approximately 2 dolphins per year.

  Approximately 258,000 sperm whales were harvested in the North Pacific by commercial whalers between 1947 and 1987, with the highest mortality occurring in 1968 when 16,357 sperm whales were harvested, after which time 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 average 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 (Angliss and Lodge 2002).

- **Reasonably Foreseeable Future External Effects.** Several of the toothed whale species range outside of the BSAI and GOA during the winter months. Therefore, foreign fisheries outside the EEZ and state-managed fisheries were identified as potential sources of mortality in the future.

Subsistence take of some stocks of beluga whales would be expected to occur in the future. Other species are not taken for subsistence purposes.

- **Cumulative Effects.** The cumulative effect of mortality from both internal and external mortality factors is considered insignificant for all non ESA-listed species 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 was also considered insignificant because the very low level of incidental take in the groundfish fisheries or other fisheries and very limited human-caused mortality from external sources is not expected to delay the recovery of sperm whale populations.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 1 on the toothed whales are largely constrained by differences between their prey and the fisheries harvest targets. FMP 1 is not expected to increase the level of competitive interactions for prey from the baseline condition and is therefore considered to have insignificant effects on toothed whale prey.

- **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 domestic groundfish fisheries, as well as 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 shifts 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 Effects.** Spatial and temporal fishing measures under FMP 1 do not deviate from the baseline, which do not appear to be causing localized depletion of prey for any species of toothed whale, and are thus determined to be insignificant.

- **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 fishing 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 Effects.** Disturbance effects of on toothed whales from the groundfish fishery under FMP 1 are determined to be insignificant at the population level.

- **Persistent Past Effects.** Past potential disturbance effects on species in this group were identified for foreign, JV, and domestic groundfish fisheries, however, there is little indication of an adverse effect. General vessel traffic likely also contributes to disturbance of 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 to these marine mammals.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external effects is found to be insignificant for endangered sperm whales and other toothed whale species, based on the lack of evidence that disturbance has a population-level effect for any of these species. For sperm whales, there is growing evidence that the whales are attracted to fishing vessels as reliable and easy sources of food.

4.5.8.8 Baleen Whales

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

Incidental take of baleen whales from groundfish fishing activities is rare. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Humpback whales are occasionally taken in the Bering Sea pollock trawl fishery through entanglement in fishing gear. The extent of interactions between bowhead whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. The extent of interactions between gray whales and the groundfish fishery are not known but some entanglement in gear does occur. Since 1989, no incidental takes of right whales are known to have occurred in the North Pacific. The low level of take of baleen whales projected to occur under FMP 1 will not affect the population trajectories of these baleen whale species, does not conflict with goals of any recovery plan for endangered whales, and is thus insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Most baleen whale species such as blue, fin, sei, and northern right whales feed primarily on copepods, euphausiids, and amphipods. Gray whales feed mostly on epibenthic and benthic invertebrates, while humpbacks and minke whales have a more diverse diet including euphausiids, Atka mackerel, sand lance, herring and capelin. The BSAI and GOA groundfish fisheries do not target these prey items (with the exception of Atka mackerel) and take very small amounts of these prey species as bycatch. Neither the abundance or distribution of zooplankton are influenced by commercial fishing operations. While a few species of baleen whales do consume herring and juvenile pollock (e.g., humpback and fin whales), changes in removal patterns of these prey species under FMP 1 would not be expected to impact their availability to whales, which can forage over vast areas and throughout the water column. The groundfish fisheries under FMP 1 are therefore unlikely to impact baleen whales through competition for prey, including the endangered blue, fin, bowhead, humpback, sei, and northern right whales.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures under FMP 1 do not deviate from the baseline, which does not cause localized depletion of prey for whales, and are therefore determined to be insignificant to both the endangered and non-ESA listed baleen whales according to the criteria established in Table 4.1-6.

Disturbance

The effects of disturbance caused by vessel traffic, fishing operations, or sound production on baleen whales in the GOA and BSAI are largely unknown. With regard to vessel traffic, most baleen whales appear tolerant, at least as suggested by their reactions at the surface. Observed behavior ranges from attraction to course modification or maintenance of distance from the vessel. Reaction to gear such as pelagic trawls is unknown, although the rarity of incidental takes suggests either partitioning or avoidance. Given their distribution throughout the fishing grounds, at least some individuals may be expected to occasionally avoid contact with vessels or fishing gear, which would constitute a reaction to a disturbance. Assuming these instances occur, the effects are likely to be temporary.

Coincident to fishing activity, as well as vessel transit, is the routine use of various sonar devices. The sounds produced by these devices may be audible to baleen whales and suggest disturbance sources. For instance, wintering humpback whales have been observed reacting to sonar pulses by moving away (Maybaum 1990, 1993), although few other cases of reaction have been documented. Given the continued occupation of the fishing grounds by these animals, and their generally positive population trends, disturbance from sonar, if it occurs in the BSAI/GOA, does not appear to have population-level effects.

Levels of disturbance to baleen whales under FMP 1 are expected to be similar to those that occurred under baseline conditions. These disturbance levels do not appear to have population-level effects on any species. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on both endangered baleen whale species and other non ESA-listed baleen whales under FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

The past/present effects on the other baleen whale group are described in Section 3.8.11 to Section 3.8.18 (Tables 3.8-11 through 3.8-18) and the predicted direct and indirect effects of the groundfish fishery under the FMP 1 are described above. The effects considered in this analysis are listed in Table 4.5-69. 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.** The low level of take of baleen whales projected to occur under the FMP 1 is considered insignificant.

- **Persistent Past Effects.** Commercial whaling in the last century has had lingering effects on most of the baleen whales in this group, with the possible exception of minke whales. These include the endangered blue whales, fin whales, sei whales, humpback whales, northern right whales and the non-ESA- listed gray whale. A full discussion of the effects of commercial whaling on baleen whales is presented in Sections 3.8.11 through 3.8.18. Subsistence whaling has also affected several of the baleen whales in the past. Gray whales are harvested both in Alaska and in Russia and have 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 quotas, which allow up to 67 strikes per year, although actual strikes have been less 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 (October 1998 and February 1999) were reported by observers in the Bering Sea pollock trawl fishery operating near Unimak Pass. The extent of interactions between bowhead whales and the groundfish fishery is 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. Based on the lack of reported mortalities of endangered 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 effect baleen whales throughout their ranges. Subsistence for gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects.** Mortality is considered cumulative, based on internal effects of the fishery and contributions from external factors. The effect is considered conditionally significant adverse for endangered fin, humpback, and northern right whales based on past effects on their populations and their endangered status. This is conditional on whether take or entanglement and other human-caused mortality affects recovery or the current population trajectory. The cumulative effect is found to be insignificant for the endangered blue, bowhead, and sei whales, based on very limited interaction with fisheries and lack of adverse external factors.

  Mortality is also considered insignificant for non ESA-listed minke whales and gray whales. Population-level effects are not anticipated for any of these species.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 1 are determined to have an insignificant effect on baleen whale species in regards to harvest of prey species due to minimal competitive overlap in species targeted by each.

- **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 as state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species would not be expected to be directly affected through their prey.

- **Cumulative Effects.** The cumulative effect of prey availability based on internal effects of the fishery and contributions from external factors is considered unlikely to result in population-level effects for all species in this group due to the limited overlap of prey species with the fisheries. These effects, therefore, are considered insignificant.

Temporal/Spatial Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under FMP 1 are determined to be insignificant.

- **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 be expected to continue to contribute some degree of effect on several species with the baleen whales group.

- **Cumulative Effects.** The effects of spatial and temporal concentration of harvest are considered cumulative based on internal and external factors. This effect is not likely to have population-level effects due to the very low overlap in prey species for this group. The contribution of the groundfish fisheries is very slight. Cumulative effects are therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Similar levels of disturbance as that which occurred to other baleen whales under baseline conditions is expected under FMP 1 and is considered insignificant.

- **Persistent Past Effects.** Some level of disturbance has likely occurred from foreign, JV, and domestic groundfish fishing, as well as 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 marine mammals.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and general vessel traffic from recreational boating and whale watching to commercial vessels would be expected to continue in future years and well as subsistence activities.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external sources is determined to be similar to the baseline condition and would 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.

4.5.8.9 Sea Otters

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

Sea otter interactions with fishing gear, either passive or active are infrequent. Laist (1997) reported that sea otter entanglement in marine debris is rare. Likewise, incidental takes in fishing gear occur at a rate too low to cause population-level effects. While the PBRs for the three sea otter stocks in Alaska were 871 (southeast), 2,095 (southcentral) and 5,699 (southwest), mortalities incidental to commercial fishing were 0, less than 1, and less than 2 per year, respectively (Angliss and Lodge 2002).

In southwest Alaska, the NOAA fisheries observer program reported eight kills in the Aleutian Islands black cod pot fishery in 1992 (USFWS 2002a). No other sea otter kills were reported by observers in the region from 1993 to 2000 (USFWS 2002a). USFWS petitioned NMFS to add sea otters to their annual *List of Fisheries*, (NMFS 2000b) and in 2000, sea otters appeared a "species recorded as taken in this fishery" in the BSAI groundfish trawl (Angliss *et al.* 2001). The USFWS is currently pursuing information regarding the extent of that possible interaction. The total fishery mortality and serious injury for the Alaska sea otter is considered to be insignificant (i.e., will not affect population trajectories). The effects on sea otters under the FMP 1 are considered insignificant, with respect to incidental catch and entanglement in marine debris.

Fisheries Harvest of Prey Species

The effects of the groundfish fisheries on sea otters is limited by differences between their prey and the species targeted and taken as bycatch by the fisheries. Sea otters consume a wide variety of prey species, including annelid worms, crabs, shrimp, mollusks (e.g., chitons, limpets, snails, clams, mussels, and octopus), sea urchins, and tunicates. Occasionally, groundfish (e.g., sablefish, rock greenling, and Atka mackerel) may also be consumed but invertebrates are considered the predominant elements of their diet (Kenyon 1969, USFWS 1994). Given the minor importance of groundfish in their diet, fisheries removals under FMP 1 are not expected to have significant effects on the abundance of sea otter prey and are therefore determined to be insignificant for 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 species' broad geographical distribution in the GOA and the Aleutian Islands. Sea otters inhabit waters of the open coast, as well as the bays and 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 one 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 all of the alternative management regimes.

Disturbance

As noted for many of the other marine mammals, the effects of disturbance caused by vessel traffic, fishing operations or sound production on sea otters in the BSAI/GOA are expected to be insignificant. Sea otters exhibit considerable tolerance for vessel traffic and in some cases are attracted to small boats passing by (Richardson *et al.* 1995). Sea otters may be more tolerant of underwater sound relative to other species, owing to the greater amount of time they spend at the surface. Similar levels of disturbance as that which occurred to sea otters under the baseline conditions is expected under the FMP 1 management regime. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on sea otters under FMP 1 are considered insignificant.

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 and indirect effects of the groundfish fishery under FMP 1 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 the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The effects of incidental take and entanglement on sea otters under FMP 1 are considered insignificant.

- **Persistent Past Effects.** Commercial exploitation for pelts had a great 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 southcental 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 self-reported to be taken in 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 killer whale predation may continue in the southwest Alaska stock, depending on the recovery of alternate prey and behavior of 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 have insignificant cumulative 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 killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al.* 1998). Since the mechanism(s) of the population decline is still under investigation, the cumulative effect on the southwest stock is considered to be conditionally significant adverse.

Prey Availability

- **Direct/Indirect Effects.** The effects of the FMP 1 on sea otters are limited by differences between their prey and the fisheries harvest targets. As such, the effects of harvest of key prey species in groundfish fisheries are determined to be 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 and sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters were identified as external effects. The overlap primarily occurs in inshore areas or offshore areas with relatively shallow water.

- **Cumulative Effects.** The cumulative effect of prey availability is determined to be insignificant, based on both internal effects of the groundfish fisheries and external factors, such as the crab fisheries. This rating is due to the very limited overlap of these fisheries and the sea otter forage species, which is not likely to result in population-level effects.

Spatial/Temporal Concentration of the Fisheries

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentrations of the fisheries are insignificant for sea otters for all of the alternative management regimes.

- **Persistent Past Effect.** The limited spatial overlap of groundfish fisheries and other fisheries in the past have limited their interaction with sea otter prey. Past effects of spatial/temporal concentration have likely been in very specific areas and 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.** The cumulative effect of the spatial/temporal harvest of prey from the internal and external effects of fisheries is considered to be insignificant, due their limited spatial overlap with sea otter habitat. These fisheries are unlikely to have population-level effects.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance under FMP 1 are expected to be similar to the baseline, which do not appear to have population-level effects on sea otters, and are therefore expected to be insignificant.

- **Persistent Past Effects.** Past effects of disturbance are primarily related to fishing and other vessel traffic as well as from disturbance 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.** Effects of disturbance of sea otters from internal and external sources is considered insignificant and unlikely to result in any population-level effects. The contribution of the groundfish fishery to the overall cumulative effect is minimal.

4.5.9 Socioeconomic Alternative 1 Analysis

4.5.9.1 Harvesting and Processing Sector

In general, the description of FMP 1 is a 5-year (2003-2007) projection of the Alaska groundfish fisheries under the management measures approved by the NPFMC through the June 2002 Council meeting. The model and analytical framework used in the analysis of the effects of FMP 1 on the harvesting and processing sectors are described in Section 4.1.7.

Model projections of ex-vessel value and product value for this FMP 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. The use of 2001 product prices and product mixes may underestimate product value for the pollock fishery (particularly the inshore component) since average product value per unit of pollock catch is expected to rise as a result of continued increases in product quality and value made possible by the AFA cooperatives. Cooperatives were in place in the catcher processor sector by 1999 but were not implemented until 2000 for the inshore and mothership sectors.

Table 4.5-71 summarizes projected impacts of FMP 1 on harvesting and processing sectors. The numbers in the table reflect the 5-year average of outcomes projected for 2003 to 2007. Primarily as a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA compared to the baseline, harvests of this species are estimated to increase by about 30 percent, from 218 thousand mt to 285 thousand mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment and groundfish payments to labor.

4.5.9.1.1 Catcher Vessels

Direct/Indirect Effects of FMP 1

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 1 there would be few significant changes in overall retained harvests of groundfish relative to the comparative baseline (Table 4.5-71). As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, retained catches of this species are expected to increase by about 31 percent. In addition, an increase in the TAC for sablefish and rockfish (components of the Atka mackerel, rockfish, sablefish, other groundfish species [A-R-S-O] group) will result in a significant increase in the retained harvests of these species. These increases would result in a significantly beneficial effect in comparison to the baseline condition. Retained harvests of pollock and flatfish are not expected to change significantly.

Ex-Vessel Value

The total ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline but not significantly. Increased Pacific cod harvests by the smaller trawl catcher vessels and pot catcher vessels account for much of the increase in groundfish ex-vessel value. Longline vessels are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase under FMP 1, but not significantly.

Impacts on Excess Capacity

No significant change in excess capacity is expected to occur under FMP 1 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. This excess capacity and the use of the race for fish to allocate TAC and PSC limits among competing fishermen are expected to decrease the net benefits to the Nation from these fisheries. They are expected to do so by decreasing 1) retention rates; 2) product utilization rates; 3) product quality; and 4) the ability of harvesters and processors to take fuller advantage of seasonal demand for some seafood products, prevent seasonal market gluts, or take advantage of seasonal differences in product quality.

<u>Average Costs</u>

No significant change in average costs is expected to occur under FMP 1 relative to the comparative baseline. It can be assumed that the use of the race for fish to allocate TAC and PSC limits among competing fishermen in some fisheries will continue to lead to excessive fixed and variable harvesting costs in those fisheries. In addition, 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, thereby increasing transit time and operating costs. Existing bycatch reduction measures will continue to have some level of success in decreasing overall bycatch mortality but not without cost to some participants in the groundfish fisheries. Because of halibut PSC limits, portions of the annual TAC specified for most flatfish species have remained unharvested. Pacific herring PSC limits have repeatedly closed Herring Savings Areas 2 and 3 to trawl fisheries directed at pollock and rock sole, yellowfin sole, and other flatfish. Area closures for salmon and crab have also had adverse economic effects on some groundfish fisheries participants.

<u>Fishing Vessel Safety</u>

No significant change in fishing vessel safety is expected to occur under FMP 1 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 an adverse effect on fishing vessel safety.

Cumulative Effects of FMP 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. Table 4.5-72 summarizes the cumulative effects for catcher vessels.

Groundfish Landings by Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are not expected to change significantly compared to the baseline except for Pacific cod which is expected to increase by about 31 percent with a significantly beneficial effect in comparison to the baseline condition.

- **Persistent Past Effects.** Foreign fisheries were the first to exploit specific fish stocks and develop commercial fisheries and markets for the products; in the course of doing so, many fisheries were over-harvested, with long-term effects on stocks and the sustainable yield of specific fisheries. Foreign vessels also began using Alaska ports for services, which led to the expansion or development of commercial services and marine infrastructure in many coastal communities. Development of joint venture fisheries led to the development of domestic fish harvesting and processing capacity, through foreign and domestic investment in harvesting and processing infrastructure. Increased global demand for seafood, especially whitefish, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. For more detail on persistent past effects, please see the Catcher Vessels Past/Present Effects Table 3.9-125.

- **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 below.

  Many of the harvesters and processors that participate in the groundfish fishery also participate in other fisheries such as the salmon, halibut, crab, and halibut fisheries. These other fisheries provide opportunities for harvesters and processors to intercept or otherwise affect groundfish stocks and harvest quotas, and provide other sources of employment and tax revenue for local communities. Activities with these fisheries may offset or exacerbate the effects from groundfish management alternatives, in both the harvesting and processing sectors. The fisheries that have the greatest potential for cumulative effects are crab (tanner and king), salmon, halibut, and state groundfish fisheries. Several classes of catcher vessels and inshore processors currently participate in these fisheries to a certain degree, and rely on the combined harvest from these fisheries. In several communities, the processing sector handles a range of products (e.g., groundfish, crab, and salmon); in other communities they are more specialized, focusing on one or two products. Where groundfish is a primary or secondary product line, a significant, long-term decrease (as compared to cyclical) in groundfish availability could jeopardize the economic viability of harvesting and processing other fish. Given projected closures and reductions in commercial crab fisheries, and the likely continuation (or further reductions) of salmon caps, some participants in these fisheries are likely to experience adverse cumulative effects. These other fisheries also affect consumer values; their product availability provides net benefits to domestic seafood consumers. However, the extent and intensity of these other fisheries can adversely affect non-consumptive and non-use values by contributing to the actual and perceived level of fishing activities in the BSAI and GOA.

  Other economic development activities may interfere with or compete for labor, services, and facilities; or provide additional employment and revenue opportunities for local communities. Direct and indirect employment opportunities associated with economic developments may offset or exacerbate the effects from groundfish management alternatives. In addition, employment opportunities directly affect the population of a community or region, and increase demand for municipal services and population based revenue sharing (such as education). The economic development activities that have the greatest potential for cumulative effects are state and federal oil and gas exploration/production (primarily potential exploration activities in Cook Inlet and potentially Dutch Harbor), military projects (contaminated site clean-up and missile defense projects in the Alaska Peninsula and Aleutian Islands), Kodiak rocket launch complex, tourism, and construction and operation of marine or air-related transportation projects. Such economic activities may offset short-term declines in fisheries, but are not likely to substitute for long-term declines, particularly where regional and community economies depend on fishing. In addition, economic development in coastal Alaskan communities, particularly in the Aleutian Islands and Alaska Peninsula, may be adversely affected by the designation of critical habitat for Steller's eider and Steller sea lions. This issue is already affecting construction of marine infrastructure projects and may affect other coastal activities.

Other sources of municipal and state revenue help fund local facilities and services. Within Alaska, regions and communities participating in the fishing industry generate revenue or receive revenue sharing from taxes on fishing (in some cases over 99 percent), and from non-fishing sources. Changes in these revenue streams may offset or exacerbate the effects from groundfish management alternatives. Changes in revenue streams also may affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt. The programs that have the greatest potential for cumulative effects are landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut), power cost equalization subsidies, and municipal revenue sharing programs from the State of Alaska (including shared education funding). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing.

Other factors could affect price and demand for groundfish, such as the rising U.S. dollar relative to currencies of countries with high levels of groundfish imports, and adverse effect on ex-vessel values of all vessels and processors, or higher or lower global harvests of fish/seafood and fish inventories that could serve as substitutes for groundfish. Similarly, there is a link between availability of seafood industry jobs and population levels in Alaska coastal communities. These factors are difficult to predict and are not considered in this analysis.

- **Cumulative Effects.** Given the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under FMP 1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (49 percent), as well as for sablefish and rockfish. Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 1. Area closures and harvest limits in other fisheries can have an impact on the groundfish fisheries; however, under FMP 1 this impact is not likely to be significant. 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 changes are not expected to have significant cumulative effects on groundfish landings by species group.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline but not significantly. It is expected to increase 9 percent to approximately $317 million.

- **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 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 above under the section Groundfish Landings by Species Group.

- **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. Marginal increases in ex-vessel value (10 percent) that are predicted for FMP 1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from FMP 1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Overall, the change in employment is not significant. A slight increase in employment is predicted (14 percent) and is likely the result of the increase in Pacific cod harvests and ex-vessel value. Similarly, a slight increase in payments to labor is expected (10 percent), but is not significant.

- **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 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 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, although slight, in groundfish employment (14 percent) under FMP 1, is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (10 percent) under FMP 1 thereby mitigating some of the reductions in other fisheries. Employment and payments to labor in the salmon fisheries have been in decline in recent years and have had serious adverse effects on the fishing industry. Any reductions in the groundfish fisheries may further exacerbate this effect. However, as employment and payments to labor are not expected to change significantly under FMP 1 from the baseline, insignificant effects are likely.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** No significant changes in excess capacity are expected under FMP 1 relative to the baseline. Current measures to reduce excess capacity and the race for fish would be maintained. For further details, please refer to the direct/indirect section at the beginning of Section 4.5.9.1.

- **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 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 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 1, no significant cumulative effects are expected for excess capacity as conditions are not expected to change substantially from the baseline.

Average Costs

- **Direct/Indirect Effects.** No significant change in average costs are expected under FMP 1 relative to the comparative baseline. It is assumed that the continued race for fish to allocate TAC and PSC limits among competing fishermen will lead to fixed and variable harvesting costs. FMP 1 measures are not expected to alter the effects of closure areas, bycatch restrictions, and PSC limits significantly from baseline conditions. More detail on average costs can be found at the beginning of this section.

- **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 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 above under the section Groundfish Landings by Species Group.

- **Cumulative Effects.** 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. Area closures also affect average costs through increases or decreases in transit time to fishing areas. 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, significant 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 1 closures do not change substantially from the baseline condition, cumulative effects on average costs in the groundfish fisheries are expected to be insignificant.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Risks to fishermen are expected to remain high under FMP 1 though this is not a significant change from the baseline condition. Regulations that require fishermen to operate farther from shore and in areas or seasons with severe weather conditions continue to have an adverse effect on vessel safety.

- **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 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 above under the section Groundfish Landings by Species Group.

- **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 1. As there are no predicted increases in area closures under FMP 1, cumulative effects on vessel safety are insignificant compared to the baseline condition.

4.5.9.1.2 Catcher Processors

Direct/Indirect Effects of FMP 1

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 1 there would be few significant changes in overall groundfish catches relative to the comparative baseline (Table 4.5-71). As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 24 percent and could have a significantly beneficial effect in comparison to the baseline condition. Catches of pollock, flatfish, and Atka mackerel, rockfish, sablefish, and other groundfish (A-R-S-O) species are not expected to change significantly.

Groundfish Gross Product Value

The total wholesale product value of groundfish outputs of catcher processors is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by head-and-gut trawl catcher processors, longline catcher processors and pot catcher processors account for much of the increase in product value. The harvest of Pacific cod by surimi trawl catcher processors and fillet trawl catcher processors is limited by AFA sideboard measures that restrict the participation of AFA-eligible vessels in other groundfish fisheries to some level of historic participation.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under FMP 1, but not significantly.

Product Quality and Product Utilization Rate

No significant change in overall product quality or product utilization rate is expected to occur under FMP 1 relative to the comparative baseline. The product value for the BSAI pollock fishery is expected to continue to increase with the predicted rise in average product value per unit of pollock catch resulting from increases in product quality made possible by the AFA cooperatives and the end of the race for fish. The end of the race for fish is also expected to lead to further increases in product utilization rate, leading to more product per unit of fish caught. Processors that are able to generate more product from a given amount of pollock are likely increase to their gross revenue. However, the continued use of the race for fish to allocate TAC and PSC limits among competing fishermen in other groundfish fisheries is expected to result in unnecessarily low product values by decreasing product quality and utilization rates.

Excess Capacity

As with catcher vessels, no significant change in excess capacity is expected to occur under FMP 1 relative to the comparative baseline.

Average Costs

As with catcher vessels, no significant change in average costs is expected to occur under FMP 1 relative to the comparative baseline.

Fishing Vessel Safety

As with catcher vessels, no significant change in fishing vessel safety is expected to occur under FMP 1 relative to the comparative baseline.

Cumulative Effects of FMP 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. See Table 4.5-73 for a summary of the cumulative effects.

Groundfish Landings by Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are not expected to change significantly compared to the baseline, except for Pacific cod, which is expected to increase by about 24 percent with a significantly beneficial effect in comparison to the baseline condition.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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 and are described in detail in Section 4.5.9.1 above.

- **Cumulative Effects.** Similar to the effects experienced by catcher vessels, catcher processors that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under FMP 1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (24 percent), though it is not significant. Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 1. Area closures and harvest limits in other fisheries can have an impact on the groundfish fisheries; however, under FMP 1 this impact is not likely to be significant. 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. 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 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 from the baseline, but not significantly.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of 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 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 wholesale product value and landing tax revenues from groundfish and 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. Marginal increases in gross product value (4 percent) that are predicted for FMP 1 may mitigate some of the declines in other fisheries. Overall, insignificant cumulative effects on ex-vessel value are expected to result from FMP 1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Insignificant effects are predicted for catcher processors under FMP 1.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of 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.** Employment and payments to labor in the salmon fisheries have been in decline in recent years and have had serious adverse effects on the fishing industry. Any reductions in the groundfish fisheries may further exacerbate this effect. The increase, although slight, in groundfish employment (5 percent) under FMP 1, may mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (5 percent) under FMP 1. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under FMP 1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** No significant changes in product quality or utilization rate are expected under FMP 1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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 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 1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** No significant changes in excess capacity are expected under FMP 1 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, please refer to 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 above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** As with catcher vessels, 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 1, insignificant 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 1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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 above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** Average costs in the groundfish fisheries are often associated or shared with other fisheries. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. Recent decreases in government subsidies, educational loan programs, and power cost sharing have indirectly increased pressure to implement or increase fish taxes as communities look for other sources of revenue. Although this can increase average costs, this effect is not expected to be significant under FMP 1. As FMP 1 closures do not change significantly from the baseline condition, cumulative effects on average costs in the groundfish fisheries are expected to be insignificant. For more details on this discussion please refer to Section 4.5.9.1.

Fishing Vessel Safety

- **Direct/Indirect Effects.** No significant change in fishing vessel safety is expected under FMP 1.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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 above under the section Groundfish Landings by Species Group.

- **Cumulative Effects.** As described under the catcher vessel section above, vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions, relative to vessel size. As there are no predicted increases in area closures under FMP 1, cumulative effects on vessel safety are insignificant compared to the baseline condition.

4.5.9.1.3 Inshore Processors and Motherships

Groundfish Landings by Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 inshore processor and mothership conditions reveals that under FMP 1 there would be few significant changes in overall groundfish catches relative to the comparative baseline (Table 4.5-71). As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 45 percent. In addition, an increase in the TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant increase in the retained harvests of these species. These increases have significantly beneficial effects when compared to the baseline condition. Retained harvests of pollock and flatfish are not expected to change significantly.

Groundfish Gross Product Value

The wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to Bering Sea pollock shore plants, Alaska Peninsula and Aleutian Islands shore plants, Kodiak shore plants, and floating inshore processors account for much of the increase in groundfish product value. Southeast Alaska shore plants and southcentral Alaska shore plants are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under FMP 1, but not significantly.

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 1 relative to the comparative baseline.

Excess Capacity

As with catcher vessels and catcher processors, no significant change in excess capacity is expected to occur under FMP 1 relative to the comparative baseline.

Average Costs

As with catcher vessels and catcher processors, no significant change in average costs is expected to occur under FMP 1 relative to the comparative baseline.

Cumulative Effects of FMP 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. See Table 4.5-74 for a summary of the cumulative effects.

Groundfish Landings by Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are not expected to change significantly compared to the baseline, except for Pacific cod, which is expected to increase by about 45 percent with a significantly beneficial effect in comparison to the baseline condition.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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 and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Processors that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. However, as with catcher vessels, and with catcher processors, this cumulative effect may not result in significant changes in groundfish landings under FMP 1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (45 percent), as well as minor increases for flatfish and certain species in the A-R-S-O complex. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 1. Area closures and harvest limits in other fisheries can have an impact on the groundfish fisheries; however, under FMP 1 this impact is not likely to be significant. 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. 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 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 from the baseline but not significantly.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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 above 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. Marginal increases in wholesale value that are predicted for FMP 1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on gross product value are expected to result from FMP 1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Insignificant effects are predicted for catcher processors under FMP 1.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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.** Employment and payments to labor in the salmon fisheries have been in decline in recent years and have had serious adverse effects on the fishing industry. Any reductions in the groundfish fisheries may further exacerbate this effect. The increase, although slight, in groundfish employment (8 percent) under FMP 1, is likely to mitigate some of the current reductions in other fisheries as described in Section 4.5.9.1. Similarly, payments to labor are also projected to increase slightly (8 percent) under FMP 1. Cumulative effects on employment and payments to labor are expected to be insignificant under FMP 1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** No significant changes in product quality or utilization rate are expected under FMP 1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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 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 1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** No significant changes in excess capacity are expected under FMP 1 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, please refer to 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 above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** As with catcher vessels and catcher processors, excess capacity still remains in other fisheries as well as the groundfish fishery. Measures such as the 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 1, insignificant cumulative effects are expected for excess capacity.

Average Costs

- **Direct/Indirect Effects.** Insignificant changes in average costs are expected under FMP 1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects, please refer to 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 above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** As described in more detail in Section 4.5.9.1, 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. Area closures also affect average costs through increases or decreases in transit time to fishing areas. As FMP 1 closures do not change significantly from the baseline condition, cumulative effects on average costs in the groundfish fisheries are expected to be insignificant.

4.5.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past and present effects on regions that participate in the groundfish fishery are described in Section 3.9 (and summarized in Table 3.9-126) and below; these regions (illustrated in Figures 3.9-9 through 3.9-13) include the 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 (all of the southeastern part of the state, from Yakutat Borough to Dixon Entrance), Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca), and Oregon coast (Lincoln, Tillamook, and Clatsop counties, the three northernmost Oregon coastal counties). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case.

Changes in the management of the groundfish fisheries can affect regions and the communities within the BSAI and GOA in two major ways. The first category of effects, which drives the second category, are direct/indirect/cumulative impacts on segments of the fishing industry within a specific region. Potential effects of management changes on industry segments (processors, catcher processors, catcher vessels) have been analyzed in the previous section for FMP 1. Depending on where these industry segments are owned and operated, a variety of revenue (ex-vessel value, product value) and expenditure (wages, purchase of goods and services, taxes and fees) effects occur and accrue to specific regions. Because many of the segments participate in multi-species fisheries (such as salmon, crab, and halibut), the combination of potential effects from groundfish combines with effects in other fisheries, resulting in cumulative effects. Regional activities and accrual of revenues and expenditures drives effects on regional economies (including direct/indirect/induced employment and income), public revenue (local and state taxes and service charges), and to a certain degree, population and other socioeconomic characteristics.

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 representative indicators used in this analysis are based on types data that can be collected and modeled in a manner that assigns potential effects to each of the six regions. In turn, these indicators have implications and, in many cases are indicative of effects on other community characteristics that are more difficult to model, such as municipal revenue, generation and support of secondary employment and economic activity, and potential effects on population. Potential effects are assigned by the predictive model to the region where processors and catcher vessels are located. Indicators used to assess potential effects of the alternatives and their implications are briefly described below:

In-Region Processing and Related Effects. Shore-based processors are closely tied to the region in which they are located. Much of the tax revenue generated through fish landed and processed accrues locally. While much of the processing employment is non-resident, processing activity generates demand for goods and services and stimulates secondary employment and economic development activity.

Regionally Owned At-Sea Processors. At-sea processors are tied to the region in which they are based. It is assumed that the majority of employment and tax revenue benefits also accrue to the region in which they are based, along with secondary economic activity. However, while not captured in the model, at-sea processors generate revenue and secondary economic development activity when purchasing goods and services in Alaskan ports such as Unalaska and Kodiak.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels. When catcher vessels deliver their catch outside their region, they bring their earnings back into the region where they are located. These earnings translate into secondary employment and economic activities in the communities where catcher vessels are located, and are captured under the direct/indirect/induced labor and income projections.

In-Region Deliveries of Regionally Owned Catcher Vessels. When catcher vessels deliver within the region they are located, their earnings are counted as expenditures to the processors to which they deliver. While these earnings are not additive, catcher vessels delivering in-region generate secondary employment and economic activities in the communities where catcher vessels are located, and are captured under the direct/indirect/ induced labor and income projections.

Total Direct, Indirect, and Induced Labor Income and FTE Employment. This indicator measures the amount of employment by region, generated by the groundfish fishery.

For more information on the economic model used to assess direct and indirect regional effects, please refer to the economic model methodology described in Section 4.1.7 of the document.

Direct/Indirect Effects of FMP 1

FMP 1 extends the management practices and trends associated with current management of the groundfish fishery. Under FMP 1, in general there is a net overall increase in fishery socioeconomic indicator values over baseline conditions for all regions, although there is a good deal of variation the degree of increase between regions (and both increases and decreases in individual indicators within specific regions). The change in total value of processing sales (combining in-region shore processors and regionally owned at-sea processors) was beneficial, although not significant in comparison to baseline conditions. Similarly, changes in total income and total employment (combining values for in-region shore processors, regionally owned at-sea processors, and regionally owned catcher vessels) were also beneficial, but not significant under FMP 1. For the more western Alaska regions, these overall changes result from increases in Pacific cod take in both the GOA (to a lesser extent) and BSAI (to a greater extent). Within the Alaska Peninsula and Aleutian Islands region, the largest gains from the Pacific cod increases are seen in the larger shore processors. (Some decreases in variables associated with catcher vessels were seen in this region, but those are assumed to primarily be associated with a model attribution difficulty for western GOA fisheries.) For the Kodiak Island region, the change from the baseline is largely explained by changes in Pacific cod numbers, but floating processors also benefit from sablefish associated gains. For the southcentral and southeast Alaska regions, changes in A-R-S-O, driven primarily by rockfish and sablefish, account for a good deal of the change from the baseline. These benefits are concentrated among the smaller vessel sectors, while vessels in the medium size classes also benefit from gains associated with cod. Net regional gains in the Washington inland waters region are largely associated with increases in cod as well. The following subsections provide a region-by-region summary of change under FMP 1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 1, total in-region groundfish processing value would increase, but not by a significant amount (with increases in the BSAI portion somewhat offset by decreases in the much smaller GOA portion of the total). In-region processing associated labor income and FTE jobs would also increase, but by less than a significant amount. 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 a negligible impact on a regional basis. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease, with relatively large decreases seen for in-region deliveries, but again this is understood to be in large part an artifact of the modeling output, so these decreases are considered less than significant. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would decrease but by a less than significant amount. For in-region deliveries, catcher vessel payments to labor and FTEs would both appear to decrease by a significant amount, but as with delivery data, this is considered to be an apparent rather than a real decrease. 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 and FTE employment would increase under this FMP, but by less than a significant amount (from a base of $226 million in labor income and 4,796 FTEs). FMP 1 is considered to result in largely beneficial, but less than significant impacts for the region as a whole.

Kodiak Island. Total in-region groundfish processing value would increase by about 23 percent under this FMP (with higher values for both BSAI and GOA, but BSAI values are not a significant portion of the regional total). Associated labor income and FTE jobs would also increase by 23 percent. Regionally owned at-sea processing value would increase, but by less than a significant amount (with the vast majority of the increase attributable to changes in BSAI values), and associated labor income and FTEs would both increase to about the same degree. (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 would increase, but not significantly, while in-region deliveries by regionally owned catcher vessels would increase by about 30 percent. Catcher vessel payments to labor increases would be beneficial, but less than significant, while FTE jobs associated with extra-regional deliveries would increase by about 25 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 30 and 23 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 and FTE employment would both increase by about 21 percent under this FMP (from a base of $66 million in labor income and 1,600 FTEs). FMP 1 has consistently beneficial impacts for the Kodiak Island region, with some significantly beneficial impacts on both a local sector and regional (or community) basis.

Southcentral Alaska. Total in-region groundfish processing value would increase by 35 percent (all attributable to GOA increases). Associated labor income and FTE jobs would also increase by 35 percent. Regionally owned at-sea processing value would increase, but by a less than significant amount (with both BSAI and GOA values increasing), and associated labor income and FTEs both increasing by a similar amount. (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 30 and 58 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase by about 30 and 32 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 58 and 68 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 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 by about 33 percent (from a base of $23 million in labor income and 567 FTEs). FMP 1 has consistently beneficial impacts for the southcentral Alaska region, with some significantly beneficial impacts on both a local sector and regional (or community) basis, although 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 marginally (all attributable to GOA increases), as would associated labor income and FTE jobs (but both remain relatively small values). Regionally owned at-sea processing value would increase (with increases in BSAI values offset to a degree by declines in GOA values) as would associated labor income and FTEs, but none of these increases would rise to the level of significance. (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 somewhat (but by less than a significant amount), and in-region deliveries by regionally owned catcher vessels would remain about the same. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase; for in-region deliveries, catcher vessel payments to labor would remain the same and FTEs would also increase but while all of these changes are beneficial, none are large enough to be considered significant. 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 FTE employment would increase, but not by amounts considered significant (from a base of $34 million in labor income and 879 FTEs). FMP 1 has consistently beneficial impacts for the southeast Alaska region, but none of these impacts are considered significant on a local sector or regional basis.

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 (with increases in BSAI offset somewhat by decreases in GOA values, although GOA values are comparatively very small), and associated labor income and FTEs would increase as well, but none of these changes rise to the level of significance. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase, but by relatively small amounts. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would also increase, but by less than significant amounts. Similarly, for in-region deliveries, catcher vessel payments to labor and FTEs would both increase, but by less than significant amounts. 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, as would FTE employment (from a base of $557 million in labor income and 10,316 FTEs), but these increases are not large enough to be considered significant. FMP 1 has consistently beneficial impacts for the Washington inland waters region, but none of these impacts are considered significant on a local sector or regional basis.

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, as would associated labor income and FTE jobs, but the amounts of these increases are considered less than significant. 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, as would FTE employment (from a base of $15 million in labor income and 318 FTEs), but none of these increases are considered significant. FMP 1 has consistently beneficial impacts for the Oregon coast region, but none of these impacts are considered significant on a local sector or regional basis.

Cumulative Effects of FMP 1

See Table 4.5-75 for a summary of the cumulative effects on regions and communities under FMP 1.

<u>In-Region Processing and Related Effects</u>

- **Direct/Indirect Effects.** Direct/indirect effects are considered insignificant for the Alaska Peninsula/ Aleutian Islands, southeast Alaska, Washington inland waters, and Oregon coast regions; effects on Kodiak Island and southcentral Alaska are considered significantly beneficial. 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. These effects are summarized below:

  Fishing trends and developments such as allocation of groundfish between inshore and offshore processors, establishment of the CDQ program, and passage of the American Fisheries Act have established the current involvement of regions and communities in the fishery. The domestic groundfish fisheries have matured to provide significant contributions to regional economies. The economies of the Alaska Peninsula/Aleutian Islands and Kodiak Island regions are heavily dependent on fishing and groundfish in particular; the economies of the other Alaskan, Washington, and Oregon regions are more diversified, and fishing provides a significantly smaller contribution to these regions.

Municipal and State Revenues: Taxes on groundfish landed and processed have become a significant source of shared revenue to local municipalities and the State of Alaska, and have contributed to municipal revenue amounts ranging from $1.3 million in the Kodiak Island region to over $7 million in the Alaska Peninsula and Aleutian Islands. Several municipalities also have fuel transfer taxes where vessels participating in the groundfish fishery generate local revenue. Furthermore, real and personal property tax on both onshore processing facilities and fishing vessels generate additional revenues for specific municipalities. Revenues directly resulting from local landings or groundfish processing are not the primary basis for local taxation in the southcentral and southeast Alaskan regions, although both received shared fish tax revenue from the state. Communities also rely on fish tax from the halibut, salmon, and crab fisheries. Downturns and closures in the latter two fisheries have resulted in loss of revenue for many communities in the three years. Revenue sharing from the State of Alaska to municipal government, through programs such as Power Cost Equalization and capital facility construction funds, have also been decreasing in recent years, forcing communities to rely more on local sources of revenue. The availability of state and local revenue has funded public services, and construction of public facility and infrastructure projects, generating local income and employment.

- **Reasonably Foreseeable Future 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 summarized below:

  Other state and federal fisheries, which may provide other fishing opportunities to vessels and processors participating in the groundfish fishery, intercept or otherwise affect groundfish stocks and harvest quotas, and provide other sources of employment and tax revenue for local communities. Activities associated with these fisheries may offset or exacerbate the effects from groundfish management alternatives, in both the harvesting and processing sector. The fisheries that have the greatest potential for cumulative effects are crab (tanner and king), salmon, halibut, and state groundfish fisheries; herring and scallops interact to a lesser degree. Several classes of catcher vessels and inshore processors currently participate in these fisheries to a certain degree, and rely on the combined harvest from these fisheries. However, entry of additional vessels into the salmon and halibut fisheries is currently limited by permit; participation in the crab fisheries is limited by vessel size, gear requirements, and license to participate in the fishery. In several communities, the processing sector handles a range of product (groundfish, crab and salmon); in other communities they are more specialized, focusing on one or two products. Where groundfish is a primary or secondary product line, a significant decrease in groundfish availability could jeopardize the economic viability of processing other fish.

  Projected closures and/or rationalization of quota for commercial crab fisheries may adversely affect fishery participants in specific communities, particularly depending on what years of fishery participation are chosen as the qualifying years to determine eligibility and quota. It may also adversely effect service suppliers in the short-term that are currently geared for meeting peak demands created by the race for fish. Given the projected continuation in reduced demand and prices for Alaskan salmon, some participants in these fisheries are experiencing significantly adverse effects, as are communities that rely on the salmon fishery for employment and income, secondary economic activity, and municipal revenue. The halibut fishery has been relatively stable in terms of stock size and price; this stability is expected to continue. Changes in state groundfish quotas could have beneficial or adverse effects on vessels and processors, depending on the alternative.

Other economic development activities may interfere with or compete for labor, services, and facilities; or provide additional employment and revenue opportunities for local communities. Direct and indirect employment opportunities associated with economic developments may offset or exacerbate the effects from groundfish management alternatives. In addition, employment opportunities directly affect the population of a community or region, and increase demand for municipal services and population based revenue sharing (such as education). The economic development activities that have the greatest potential for cumulative effects are oil and gas exploration and production (primarily potential exploration activities in Cook Inlet, and potentially out of Dutch Harbor), military projects (contaminated site clean-up and missile defense projects in the Alaska Peninsula and Aleutian Islands), tourism, and construction of public marine or air-related transportation projects. Reduced levels of state and municipal funding is having an adverse effect on employment and support activities that are typically created by public projects, particularly in Alaska.

Other sources of municipal and state revenue may help fund construction and operation of local facilities, and provide services. Within Alaska, regions and communities participating in the fishing industry generate revenue or receive revenue sharing from taxes on fishing (in some cases over 99 percent), and from non-fishing sources. The level of income differs depending whether or not municipal governments levy a raw fish tax on ex-vessel value landings, or tax fuel transfer or other fisheries related services. Changes in these revenue streams may offset or exacerbate the effects from groundfish management alternatives. Changes in revenue streams may affect the communities' ability to provide municipal services, fund capital projects, borrow money, and retire debt service. The programs that have the greatest potential for cumulative effects are revenues from landing taxes on non-groundfish fisheries (such as salmon, crab, and halibut), power cost equalization, and municipal revenue sharing programs from the State of Alaska (including shared education funding). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. The dramatic downturn in the salmon industry, coupled with state budget cuts to address a deficit are likely to continue to adversely affect many Alaskan coastal communities.

Other natural factors may affect the productivity of groundfish and other fisheries upon which regions and communities depend. These factors would include short-term cyclic changes and long-term climate changes.

- **Cumulative Effects.** Cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. The influence of external factors is adverse for the most part, which offset increases in in-region processing. The exception occurs in portions of the Alaska Peninsula, where increases in processing due to gains in Pacific cod are overshadowed by external factors. Trends in multi-species fisheries and other sources of municipal and state revenue, primarily due to the downturn in salmon and reductions in state and municipal revenue, result in conditionally significant adverse effects on in-region processing and municipal revenue. The Kodiak and southeast Alaska region is experiencing similar declines in the salmon industry and municipal revenues; however, with a more diversified economy and larger population base, adverse effects are not as severe, and are considered insignificant.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** Direct /indirect effects are considered insignificant for all six 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. At-sea processors are affected by changes that have occurred in the groundfish industry related to allocation, and by their participation in multi-species fisheries. However, participation in multi-species fisheries is low compared most Alaskan at-sea processors. As the majority of at-sea processors are owned by Washington State residents, tax revenue generated is not as significant a factor on a local or regional basis.

- **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. Given the limited participation in multi-species fisheries and the relatively diversified economy in Washington, where the majority of at-sea processors are based, external reasonably foreseeable future affects are not likely to have much of a contribution to cumulative effects.

- **Cumulative Effects.** Cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. Direct/indirect effects are insignificant for all regions. Reasonably foreseeable external effects will not contribute much to cumulative effects, except in Kodiak, where most of the Alaska at-sea processor fleet is based. As indicated previously, with a more diversified economy and population base, cumulative effects will be insignificant.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Direct/indirect effects are insignificant for the Alaska Peninsula/ Aleutian Islands, Kodiak Island, southeast Alaska, Washington inland waters, and Oregon coast regions; effects on southcentral Alaska are considered significantly beneficial. 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.

- **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 alternatives; for more detail, see the discussion of persistent past effects under In-Region Processing.

- **Cumulative Effects.** Extra-regional deliveries of regionally owned catcher vessels decrease but are considered to be cumulatively insignificant; vessels that participate in multi-species fisheries such as crab and salmon, may experience conditionally significant adverse cumulative effects, and are primarily based out of the Alaska Peninsula/Aleutian Islands and Kodiak. Reductions in state and municipal revenue, and limits on other economic development activity besides fishing are likely to further contribute to cumulative adverse effects in the Alaska Peninsula and Aleutian Islands.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Direct indirect effects are insignificant for the Alaska Peninsula/Aleutian Islands, southeast Alaska, Washington inland waters, and Oregon coast regions; effects on southcentral Alaska and Kodiak Island are considered significantly beneficial. 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.

- **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, for all alternatives.

- **Cumulative Effects.** In-region deliveries of regionally owned catcher vessels are likely to decrease, but are considered to be cumulatively insignificant; vessels that participate in multi-species fisheries such as crab and salmon may experience conditionally significant adverse cumulative effects, and are primarily based out of the Alaska Peninsula/Aleutian Islands and Kodiak. Reductions in state and municipal revenue and limits on other economic development activity besides fishing are likely to further contribute to cumulative adverse effects in the Alaska Peninsula and Aleutian Islands.

Total Direct, Indirect, and Induced Labor Income and FTE's

- **Direct/Indirect Effects.** Direct, indirect, and induced labor income and employment is likely to increase for all regions. Significant increases are expected for Kodiak Island and southcentral Alaska. 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.

- **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, for all alternatives.

- **Cumulative Effects.** Direct, indirect, and induced labor income and employment is likely to increase in all regions, including a significant increase for Kodiak Island and southcentral Alaska. Within Washington and Oregon, 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, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are insignificant in most regions, except in the Alaska Peninsula and Aleutian Islands, where cumulative effects are conditionally significant adverse.

4.5.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past and 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 (Table 4.5-76). The representative indicator used in this analysis is the allocation of catch to CDQ groups. It should be noted that the 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 1

Under this FMP, 7.5 to 10 percent of all BSAI groundfish quotas 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 this FMP, TAC increases, so no adverse impacts to the CDQ program or regions are anticipated.

Cumulative Effects of FMP 1

Cumulative effects on CDQ for FMP 1 are summarized in Table 4.5-76.

<u>CDQ Allocations</u>

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 1 on the CDQ program are insignificant.

- **Persistent Past Effects.** The past/present effects on the CDQ program for groundfish fisheries occur within the BSAI coastal region. Management actions taken include: persistent limitations on economic development and associated employment activities; 1992 CDQ program established during inshore/offshore pollock fishery allocation process; 1995 BSAI halibut and sablefish CDQ implemented (7.5 percent of TAC); 1996 program incorporated into MSA; 1998 AFA increased

CDQ pollock allocation to 10 percent of TAC, initial pollock allocation set at 7.5 percent of TAC; and 1998 multi-species groundfish CDQ program implemented (7.5 percent of TAC). The comparative baseline statement for CDQ includes the 65 ANCSA communities in 6 CDQ regions that participate in the program. Program benefits include flow of royalties, employment, and income to areas typically characterized by limited commercial economic opportunities. CDQ investment has resulted in increased participation in both regional and local fisheries. Past/present effects for CDQ groups include the effects of stock levels and fishery closures in other fisheries where CDQ groups have quota share, primarily in crab and halibut. Natural fluctuations in these stocks drive fishery opening and closures. As species and percent for which share has been allocated to CDQs increases, the involvement in multi-species fisheries increases.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. Many harvesters and processors participate in salmon, crab, federal groundfish, and halibut. Crab CDQ groups will likely benefit due to rationalization of that fishery as CDQ shares are projected to rise. CDQ groups participating in salmon fisheries will be adversely effected because price is down and runs vary. Halibut share of CDQ groups will hold stable. Other economic development activities will be effected by community infrastructure projects creating employment and income opportunities. Currently the trends in funding available to CDQ communities are somewhat offsetting. There are funds available for infrastructure improvement through the Denali Commission, but state revenue sharing and related projects are generally decreasing. Changes in federal and state fiscal policies are likely to occur and effect CDQ communities. Long-term climate change and regime shifts will continue to influence the openings and closures of groundfish and other fisheries where CDQ groups are participants.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for the CDQ Program, and the effect is judged to be insignificant. With guaranteed CDQ shares through the CDQ program, no significantly adverse cumulative impacts to the CDQ program are expected.

4.5.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past/present effects on subsistence 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 (Table 4.5-77). 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 1

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, specifically the loss of income 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. Under this FMP, 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. Salmon bycatch would essentially remain the same as under baseline conditions and is determined to have no significantly adverse effects 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 be neutral or 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 1

The predicted direct and indirect effects of the groundfish fishery under the FMP 1 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 and 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 such as income and joint production opportunities (Table 4.5-77).

Subsistence Use of Groundfish

- **Direct/Indirect Effects.** Under this FMP, no changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline subsistence groundfish fishing conditions.

- **Persistent Past Effects.** Foreign, JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. The comparative baseline indicates that groundfish makes a relatively modest contribution to the total subsistence resource base, but comprises up to 9 percent of the base in some commercial groundfish communities.

- **Reasonably Foreseeable Future External Effects.** Other fisheries have a potential to adversely contribute to the groundfish fisheries. The state-managed groundfish fishery activity could impact subsistence groundfish fishing. Other economic development activities and sport and personal use of subsistence use of groundfish do not significantly contribute potential effects on the subsistence use of groundfish. There are relatively low levels of subsistence use of groundfish in comparison to other fish resources. Infrastructure development, and sport use, and personal use are unlikely to cause a decline in groundfish stocks. Long-term climate change and regime shift have the potential to adversely affect groundfish stocks due to the natural fluctuations in groundfish stocks.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for subsistence use of groundfish, but is judged to be insignificant. The external impacts of economic development activities, sport use, and personal use of subsistence groundfish are not likely to contribute to significantly adverse cumulative effects on the groundfish fisheries. However, other state-managed fisheries could have adverse impacts on 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.** There is no indication that this FMP would have an adverse impact 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; while sea lions have been used for subsistence since pre-contact times, there has been a long-term decline in relative importance of marine mammals in local diets; and commercial groundfish fishing takes prey species utilized by Steller sea lions, although the relative impact of this interaction is the subject of continuing research. With regard to past and present management actions, the MMPA (1972) limits subsistence take to Alaska Natives. The Steller sea lion population west of 144 degrees west longitude was declared endangered in 1990 (and populations east of line were declared threatened). The subsistence use of Steller sea lions reduces the number of Steller sea lions as does any other activity that results in Steller mortality, but by definition, but Steller subsistence use may not be directly related to overall Steller population decline. Most activity occurs in communities in the southwest portion of the state, although a significant number of Steller sea lions are harvested in a handful of other communities.

- **Reasonably Foreseeable Future External Effects.** Other commercial federal and state fisheries compete for sea lion prey and are likely to adversely contribute to the state of the sea lion population. Subsistence uses of Steller sea lions are not likely to adversely contribute to the groundfish fisheries. Other economic development activities and long-term climate change and regime shifts could adversely contribute to Steller sea lion subsistence activities. Community marine port and harbor development could potentially impact habitat and increase Steller sea lion disturbance. Long-term climate change could potentially effect recovery of Steller populations.

- **Cumulative Effects.** Under FMP 1, while an adverse cumulative effect is identified for subsistence use of Steller sea lions, the effect is judged to be insignificant. However, the cumulative effects of take, the continuing endangered status, and long-term decline in abundance are likely having population-level effects, but not enough to have significant indirect impacts to subsistence. The external impacts of other fisheries, other economic development activities, and subsistence uses of Steller sea lions are not likely to contribute adversely to the groundfish fisheries.

<u>Subsistence Use of Western Alaskan Salmon and Bycatch in the Groundfish Fishery</u>

- **Direct/Indirect Effects.** Under this FMP, salmon bycatch would essentially remain the same as under baseline conditions, therefore adverse direct/indirect impacts to subsistence salmon fisheries are expected to be insignificant.

- **Persistent Past Effects.** Salmon has been utilized for subsistence since pre-contact times; salmon bycatch in the groundfish fishery raises concerns especially during years of poor runs in western Alaska, but current data does not allow for a clear demonstration of the significance of adverse impact. Other past and present management actions include the adverse contribution of commercial salmon fishing on subsistence use of salmon; Area M salmon fishing closures were implemented to decrease intercept of salmon returning to areas further west and north. The comparative baseline statement for subsistence use of salmon indicated that it is part of the household economic base and sociocultural institutions in dozens of communities in western and interior Alaska.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts could all adversely contribute to effects on salmon subsistence activities. Salmon intercept from other commercial fisheries has the potential to contribute to poor salmon returns in western Alaska. Other economic development activities and community infrastructure development could potentially effect salmon spawning and rearing habitat. Long-term climate change could potentially effect at-sea salmon survival and reduce salmon runs. Sport and personal use or subsistence use of salmon is not likely to contribute to adverse effects on the salmon population.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for subsistence use of salmon, and is judged to be adverse but insignificant. However, given the depressed stock status of salmon runs in western Alaska, adverse contributions from external factors, and the salmon bycatch in the BSAI and GOA, sustainability of depressed salmon stocks could be adversely impacted, but are considered insignificant.

Indirect Impacts on Other Subsistence Activities (Income and Joint Production Opportunities)

- **Direct/Indirect Effects.** Under this FMP, catcher vessel activity and labor income are anticipated to be neutral or increase, therefore no adverse indirect impacts 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 a history of joint production as a part of local groundfish and other commercial fishery activities; and income from fishing used for investment in subsistence similar to use of income from other activities. The comparative baseline statement for indirect impacts on other subsistence activities indicates that joint production activity has been largely undocumented; activity that does occur is primarily associated with the smaller vessel classes within the fleet; vessels used as a platform or to access a number of subsistence activities in addition to fishing (e.g., hunting and berry picking).

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts could all adversely or beneficially contribute to indirect subsistence activities. Other fisheries and other economic development activities could potentially effect income available for pursuit of subsistence activities. For example, current reductions in salmon fishing due to lower prices is likely to reduce joint production opportunities. Long-term climate change could potentially effect groundfish stocks and opportunity for joint production and income. Effects of sport and personal use on indirect subsistence activities is minimal.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for indirect subsistence use, and the effect is judged to be insignificant. Catcher vessel activity, and joint production opportunities are not expected to be affected adversely. However, the external impacts of other fisheries, other economic development activities, and long-term climate change and regime shifts could potentially contribute adversely to the indirect subsistence use.

4.5.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past and present effects on Environmental Justice are described below (Table 3.9-126). 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 (Table 4.5-78).

Direct/Indirect Effects of FMP 1

Potential impacts that drive Environmental Justice issues include employment/municipal revenue 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 predominately 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 204 jobs; therefore, no Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $492 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 adult male 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 this FMP, the total value of catcher vessel operations would appear to decrease as would corresponding labor income and employment; therefore, a potential environmental justice impact would result, but this is likely to be at least in part an artifact of the output model distribution rather than an impact that would be high and adverse.

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 134 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $100 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 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 the adult male population of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominately Alaska Native (or comprised of other identified minority populations). Under this FMP, 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 of any consequence 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 this FMP 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; however catcher vessel associated values decrease, but these changes are not tied to environmental justice concerns.

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 this FMP 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 analogous catcher vessel associated values, 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 this FMP, at-sea processing labor income and FTEs increase (if by less than significant amounts), 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 this FMP 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.

CDQ Region. The CDQ region is predominately 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 above, the CDQ program and region would not experience adverse impacts under this FMP, therefore no associated environmental justice impacts are likely to result.

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 include the following:

- Harvest of groundfish (which occurs to some extent in all four Alaska regions), 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).

- The loss of income from fishing that would otherwise be directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production (which occurs to some extent in all four Alaska regions).

While there are some concerns about the effect of the groundfish fishery on Steller sea lions and salmon bycatch, it has been determined that fishing under FMP 1 is not having a significantly adverse contribution to Steller Sea lion and salmon populations and their availability for subsistence harvest. Significantly adverse direct/indirect impacts to subsistence activities are not foreseen under this FMP, therefore no associated Environmental Justice impacts are anticipated.

Cumulative Effects of FMP 1

The predicted direct and indirect effects of the groundfish fishery under the FMP 1 are described above. The past/present effects on Environmental Justice issues are described in Section 3.9.6. 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 4.5-78).

<u>Environmental Justice</u>

- **Direct/Indirect Effects.** Under FMP 1, insignificant effects to baseline Environmental Justice issues are anticipated.

- **Persistent Past Effects.** Persistent past effects include the following events and activities. Enactment of local and state taxes and the Fisheries Resource Landing Tax have increased revenues to many Alaskan communities, including those with significant Alaska Native populations. The initiation of the MSA phased out foreign fishing activities, adversely effected salmon populations on the high seas. The establishment of the CDQ program encouraged investment by Alaska residents from predominantly Alaska Native communities in groundfish fisheries, in order to promote economic development. Commercial fishing has become a dominant source of employment and income for many Native Alaskans.

- **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. Other fisheries, other economic development activities, and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. Other federal and state fisheries allocate quota, to CDQ groups, provide opportunities for non-CDQ Alaska Natives to participate in fish harvesting and processing, and provide tax revenue to communities in Alaska with substantial Alaska Native populations. Changes in economic conditions in these other Alaska fisheries (e.g., crab fisheries closures and reduced salmon fisheries) could impact Environmental Justice issues in several ways in combination with changes in relative allowable catch, value of groundfish and associated revenues to Alaskan Native communities.

Environmental Justice issues could be impacted by decreases in other economic activities that create opportunities for employment and income for Alaska Natives. Reductions in construction of public and private infrastructure, and limited economic development activities in many small coastal communities can adversely affect Alaska Natives.

Reductions in state and local revenue may adversely affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire debt service. When these communities have significant Alaska Native populations, adverse Environmental Justice effects may result.

Fluctuations in natural conditions, such as short-term and long-term climate change, could adversely affect availability of fish and wildlife for Alaska Native subsistence use and commercial fishing.

- **Cumulative Effects.** Under FMP 1, an insignificant cumulative effect is identified for Environmental Justice, with the exception of the Alaska Peninsula/Aleutian Islands. The direct/indirect effects on income for subsistence pursuits, and participation and employment opportunities for Alaska Natives in the fishery generally increase. Reductions in revenues to local communities could potentially effect Environmental Justice issues, but not of a magnitude to be significant. Effects from bycatch of salmon and Steller sea lion subsistence activities are cumulatively insignificant. The external effects from the crab closures and downturn in the salmon industry and reductions in employment funded by public revenue, and reductions in revenue to Alaskan Native communities are adverse, primarily in the Alaska Peninsula/Aleutian Islands, where cumulative effects are conditionally significant adverse for Environmental Justice issues.

4.5.9.6 Market Channels and Benefits to U.S. Consumers

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past/present effects on market channels and benefits to U.S. consumers are described in Section 3.9 (Table 3.9-127) 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 benefits to U.S. consumers (Table 4.5-79).

Direct/Indirect Effects of FMP 1

FMP 1 is not expected to have a significant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Under FMP 1 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 $1.5 billion, the projected 5-year mean of the total wholesale product value of BSAI and GOA groundfish after primary processing under FMP 1. This wholesale product value mean is higher than the comparative baseline, but the increase is not significant.

Cumulative Effects of FMP 1

For a summary of the direct/indirect and cumulative ratings see Table 4.5-79.

Market Channels and Benefits to U.S. Consumers

- **Direct/Indirect Effects.** Under this FMP, 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.** Other fisheries are adversely or beneficially contributing to market channels and benefits to U.S. consumers of groundfish products. Other fisheries provide relatively stable levels of seafood products to domestic and foreign markets; the supply of fish products could be influenced by competition in markets; foreign fisheries are being over fished; and there has been an increasing trend in domestic seafood consumption. Long-term climate change and regime shifts have the potential to adversely affect the market channels and benefits to U.S. consumers of groundfish products due to the natural fluctuations in groundfish stocks.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for benefits to U.S. consumers of groundfish products, and the effect is judged to be insignificant. 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 shifts could adversely effect availability for market channels due to the natural fluctuations in groundfish stocks. Cumulative effects under FMP 1 are considered to be insignificant.

4.5.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (including Non-Consumptive and Non-Use Benefits) Alternative 1 Analysis

The predicted direct and indirect effects of the groundfish fishery under FMP 1 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 the 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 indicators used in this analysis include the benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits) (Table 4.5-80).

Direct/Indirect Effects of FMP 1

FMP 1 is predicted to have no significant effects on the level of benefits the Bering Sea and GOA marine ecosystems and associated species provide relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 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 4.5.10 of this Programmatic SEIS.

The comparative baseline for the benefits that humans derive from the Bering Sea and GOA marine ecosystems is described in Section 3.9.7. To summarize this section, these 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 may 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 Programmatic SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of the 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.

FMP 1 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. These measures include a network of spatial/temporal closed areas that disperse fisheries geographically and seasonally, a prohibition on the use of non-pelagic trawl gear to fish for pollock in the BSAI, bycatch reduction measures such as the full retention requirement for Pacific cod and pollock, and measures to reduce the incidental catch of seabirds. Furthermore, as discussed in Section 4.5.10, FMP 1 is not expected to result in a significant change in the quantitative measures of any indicators of fishing impacts on marine ecosystems relative to the baseline. Consequently, the change in the level of benefits these ecosystems provide is not expected to be significant.

Cumulative Effects of FMP 1

For a summary of the direct/indirect and cumulative ratings please refer to Table 4.5-80.

<u>Benefits Derived from Marine Ecosystems and Associated Species</u>

- **Direct/Indirect Effects.** Under this FMP the adverse effects that the Alaska groundfish fishery could have on marine ecosystems are increased. FMP 1 is predicted to have a conditionally significant adverse impact on the levels of some of the benefits these ecosystems and the associated species they generate.

- **Persistent Past Effects.** Persistent past effects on benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits) include the following: an increase in public awareness of marine ecosystems (e.g., BSAI and GOA marine ecosystems) and associated endangered species (e.g., Steller sea lions); increased participation in recreational fishing and eco-tourism activities; and public perception associated with lawsuits challenging NOAA Fisheries for failing to meet the requirements of the Endangered Species Act in its management of Alaska groundfish fisheries. These persistent past effects drive the public to value the marine ecosystem and associated species and the public derives satisfaction from knowing that the structure and function of these ecosystems are protected.

- **Reasonably Foreseeable Future External Effects.** Other fisheries are adversely contributing to benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits). Fishing levels in other domestic and foreign fisheries may be affecting the productivity of the marine ecosystem. Long-term climate change and regime shift has the potential to adversely affect the benefits the public derives from marine ecosystems and associated species due to the natural fluctuations in groundfish stocks.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for the benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits), and the effect is judged to be conditionally significant adverse. The external impacts of other fisheries have the potential to contribute adversely to the benefits the public derives from marine ecosystems and associated species. Current fisheries management practices could continue the introduction of non-native species; changes in pelagic forage availability; removal of top predators (potential for seabird by-catch and subsistence harvests of marine mammals); and increased 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.

4.5.10 Ecosystem Alternative 1 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 FMP 1 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.

The analyses of the alternatives examine three major factors through which commercial fishing can typically affect ecosystem characteristics:

1. Predator-prey relationships.

2. Energy flow and balance.

3. Diversity.

Within these three categories, ten indicators have been selected to allow assessments of the potential future direct, indirect, and cumulative effects of the alternatives:

To assess effects on predator-prey relationships:

1. **Change in pelagic forage availability.** This is a change in the availability of fish such as walleye pollock, Atka mackerel, herring, and other species that serve as food for top predators such as seabirds and marine mammals.

2. **Spatial and temporal concentration of fishery impact on forage.** This is the pattern in space and time of the commercial fishing effort.

3. **Removal of top predators.** This is a decrease in the number of top-predator fish (e.g., Pacific halibut, arrowtooth flounder), seabirds, or marine mammals in the ecosystem, either through direct removal (e.g., targeted catch, bycatch, subsistence harvest) or indirect biological pathways (e.g., decline in reproductive success).

4. **Introduction of non-native species.** This is the establishment of new populations of plants or animals that originate in other marine ecosystems foreign to the BSAI or GOA. In other parts of the world, such as the Great Lakes, introduced species have resulted in major changes to ecosystem characteristics, almost always considered undesirable for biological and economic reasons.

To assess effects on energy flow and balance:

5. **Energy removal.** This is a decrease in the total amount of energy in the ecosystem that is available as nutrients for living organisms.

6. **Energy redirection.** This is a change in the pattern of energy flow within the ecosystem. For example, a shift in energy from one part of the food web to another.

To assess effects on diversity:

7. **Change in species diversity.** This is an increase or decrease in the number of different species in the ecosystem.

8. **Change in functional (trophic) diversity.** This is a change in the variety of species that make up a trophic guild, that is, a group of species that obtain food in similar ways.

9. **Change in functional (structural habitat) diversity.** This is a change in the variety of organisms, such as corals, that grow in ways that provide structures for other species to live in and around. Many of the species providing structural habitat are bottom-dwellers.

10. **Change in genetic diversity.** This is a change in the variety of genes within a population (single species). In general, greater genetic diversity bestows a greater ability of the population to deal with environmental stressors such as changes in food availability, water quality, or climate.

Direct/Indirect Effects FMP 1 on Ecosystems

The following sections discuss the potential direct/indirect effects of FMP 1 on the ten indicators noted above.

Predator-Prey Relationships

Pelagic forage availability is assessed by evaluating population trends in pelagic forage biomass for species with age-structured population models. This includes walleye pollock in the GOA (Figure H.4-17 of Appendix H) and Bering Sea walleye pollock and Aleutian Islands Atka mackerel (Figure H.4-18 of Appendix H). Trends in bycatch of other forage species (herring, squid, and forage species group) in the groundfish fisheries are used as a measure of the potential impact on those groups in the BSAI and GOA (Figure H.4-19 and Figure 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 comparative baseline levels. Under FMP 1, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would decline by about 10 percent from the baseline, and pelagic forage biomass (specifically, walleye pollock) in the GOA would increase by about 50 percent over the baseline. Twenty-year biomass projections show similar trends. Average biomass would remain within the bounds of estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species would increase by over 75 percent in the BSAI and decline by about 5 percent in the GOA. The projected absolute quantity of bycatch in each region is relatively small (2,930 mt and 250 mt, respectively). Estimates of forage biomass from food web models of the EBS suggest that this bycatch would be a small proportion of the total forage biomass (Aydin *et al.* 2002). However, the lack of population-level assessments for some species in the forage species group means that corresponding species-level effects are unknown. On the basis of this analysis, FMP 1 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability.

Spatial and Temporal Concentration of Fishery Impact on Forage

Spatial and temporal concentration of fishery impact 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 also considered. FMP 1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial and temporal allocation of TAC for pollock and Atka mackerel, resulting in an insignificant effect of the spatial/temporal concentration of the fishery on forage species. Bering Sea pollock fisheries have been showing an 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 the fur seals.

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 levels 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 (MSST for groundfish and ESA listing or lack of recovery to 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 levels of the groundfish species for which we have age-structured models, and which dominate the catch, change less than 0.2 percent on average. Similarly, top predator bycatch amounts would increase slightly in the BSAI (+5.9 percent) and decrease slightly, on average, in the GOA (-1.8 percent) relative to the baseline. The absolute values of average catch of these species are estimated to be 715 mt and 1,290 mt in the respective regions under this FMP. The significance threshold for this effect is defined as catch levels high enough to cause the biomass of one or more top level predator species to fall below minimum biologically acceptable limits (MSST for target species and ESA listing or lack of recovery to an ESA-listed species) (Table 4.1-7).

The above indicators result in no change to the established baseline condition. The baseline determination concludes that historical whaling has resulted in low present-day abundance of whale species in the North Pacific Ocean. FMP 1 would not further impair the recovery of these species through direct takes. Similarly, levels of seabird and pinniped bycatch in groundfish fisheries in this alternative would not lead to an ESA listing for any of those populations or prevent any of the species from recovery under the ESA. Sections 4.5.7 and 4.5.8 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 identify the potential impacts of groundfish fisheries on this resource. Section 4.5.3 discusses current trends in shark populations as considered in the other species category. Stability in trophic level of the catch is indicative of little effect of the fishery on top predators within the target and PSC species groups (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). See Section 4.5.1 for details on these target species and Section 4.5.2 for Pacific halibut. Overall, this alternative would have insignificant and unknown effects on top predators.

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 the Alaskan marine food web structure. Recent work done primarily in Port Valdez and PWS shows that biological introductions of non-indigenous species has occurred, although these introductions cannot be ascribed to a particular vessel type such as oil tankers or fishing vessels (Hines and Ruiz 2000). There have been 24 species of non-indigenous plants and animals documented in Alaskan waters, primarily in shallow-water marine and estuarine ecosystems, with 15 species recorded in PWS, where most of the research has been conducted. One example of a likely introduction is the predatory seastar (*Asterias amurensis*), which is found in other areas of Alaska but has not previously been found in Cook Inlet. These predators have the potential to have a major impact on benthic communities. However, impacts from these introductions have not yet been observed in Alaskan waters. It is possible that most of these introductions were from tankers or other ships 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 that transit in Alaskan inshore waters has been identified as a threat in a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). The state management plan emphasizes the seriousness of non-native introductions, with respect both to biological changes and resulting economic impacts. Therefore, the potential for one or more non-native species to establish viable Alaskan populations is evaluated as having a conditionally significant adverse effect on the comparative baseline.

Total groundfish catch levels are used as an indicator of potential changes in the amount of these releases via groundfish fishery vessels (Figure H.4-27 and Figure H.4-28 of Appendix H, Table 4.5-81). Under FMP 1, total catch would decrease by less than one percent in the BSAI and increase by about 12 percent in the GOA relative to the baseline. These projected 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 hull-fouling organism release. Under FMP 1, therefore, there would be an insignificant change from the baseline with respect to the potential for introducing non-native species from fishing vessels and gear.

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 catch, were less than one percent of the total system energy as determined by mass-balance modeling of the system and were determined to have an insignificant impact on the ecosystem. Total retained catch removals under FMP 1 would decrease by less than one percent in the BSAI and increase by about 20 percent in the GOA relative to the baseline (Table 4.5-81). These are still less than one percent of the total system energy as estimated from mass-balance modeling for the eastern Bering Sea. Therefore, impacts on energy removals are determined to be insignificant 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). Further examination of the potential for fishery removals to induce changes in system-level characteristics should be undertaken using present-day ecosystem models of the BSAI and GOA.

Energy re-direction, in the form of discards, disposal of fish processing offal, or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the system. For example, discards of dead flatfish or small benthic invertebrates might be consumed at the surface by scavenging birds that would normally not have access to those sources of energy. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms, making them more vulnerable to predation. Discards and offal production can cause local enrichment and change species composition or water quality if discards or offal returns are concentrated locally. These effects were determined to be insignificant at the ecosystem level in the baseline. Trends in total discards (Table 4.5-81, Figure H.4-29 and Figure H.4-30 of Appendix H) under FMP 1 show about a 5 percent increase in the BSAI and a 15 percent decrease in the GOA relative to the baseline. This amount of change is determined to be small in comparison to historical amounts of discards and is determined to have an insignificant potential 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 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, thus changing the distribution of biomass 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. Large, old fishes may be more heterozygous than younger fish (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 defined as 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, minimum biologically acceptable limits (MSST for target species, ESA listing for non-target) (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 4.5-81, Figure H.4-31 and Figure 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 of insignificance were concluded for most of these indicators, and were unknown for skates and sharks.

Under FMP 1, closed areas would remain the same and bycatch of HAPC biota would increase by about 10 percent in the BSAI and decrease by almost 30 percent in the GOA. Although it is unknown whether bycatch amounts of HAPC biota would be at levels high enough to bring these species to minimum population thresholds, area closures would likely be sufficient to prevent species removal for these sessile animals. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds. 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 the risk of their falling below minimum population abundance thresholds. Although forage species population levels are not known, their relatively high turnover rates and the ban on forage fish fisheries in this alternative is considered sufficient to protect them from falling below minimum biologically acceptable limits. However, some of the species in the forage group are not well studied (such as stichaeids, gunnels) and life-history parameter determination should be a priority in the future to better assess the risk of their falling below acceptable population thresholds of abundance.

On the basis of the preceding considerations, we determine that FMP 1 would have insignificant and unknown effects on species diversity. More years of survey data and life history parameter determination for skates, sharks and grenadier species may better define population trends and the need for further protection. See Sections 4.5.1 (target species), 4.5.2 (prohibited species), 4.5.3 (other species), 4.5.4 (forage species), 4.5.5 (non-specified species), 4.5.6 (habitat), 4.5.7 (seabirds) and 4.5.8 (marine mammals) for more detailed analyses of the potential for fishery removals to affect minimum population thresholds and species diversity for each of these groups.

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 defined as catch removals high enough to cause a change in functional diversity outside the range of natural variability observed for the system. 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. Under FMP 1, the species composition and amounts of removals, and the bottom gear effort and bycatch amounts of HAPC biota (Table 4.5-82, Figure H.4-31 and Figure H.4-32 of Appendix H), would be relatively similar to the comparative baseline, in which fishing impacts on functional guild diversity were determined to be insignificant for trophic diversity and structural habitat diversity.

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. Some of these organisms have life-history traits that make them very sensitive to fishing removals. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Therefore, it is important to evaluate the spatial distribution of areas closed to bottom fishing with respect to coral distribution to ensure a broad spatial distribution that would be necessary for them to fulfill their functional role. Present-day Steller sea lion trawl closures are spread throughout the Aleutian chain, but these closures may be more inshore than most of the coral. For this reason, the areas closed to trawling in this alternative may not be sufficient to provide additional protection beyond the baseline for these sensitive organisms.

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. Genetic diversity has not been well assessed in the comparative baseline and is unknown for many species. On the basis of evidence from other, more highly fished systems, the degree of spatial/temporal management of TAC, and the lack of target species falling below MSST due to a decline in genetic diversity, it is concluded that effects of fishing on genetic diversity are insignificant or unknown. Under FMP 1, no target species would fall below MSST and the same spatial and temporal management of TAC and similar catch and selectivity patterns in the fisheries would apply, so we would expect an insignificant impact of fishing on genetic diversity. However, because actual genetic diversity remains unknown for most species, the potential direct/indirect effects of fishing on genetic diversity are also largely unknown.

Cumulative Effects Analysis of FMP 1 on Ecosystems

The following sections briefly discuss the potential cumulative effects of FMP 1 on the ten ecosystem indicators explained in Section 4.5.10. These potential cumulative effects are summarized in Table 4.5-82. Data and calculations supporting the energy removal analyses for the alternatives are presented in Section 4.5.11.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 1 on pelagic forage availability are expected to be insignificant. The BSAI pelagic forage biomass, as estimated by Bering Sea pollock and Aleutian Islands Atka mackerel, is predicted to decrease by 9.2 percent, and the total biomass of GOA pollock is predicted to increase by 50.9 percent. These fishery-induced changes would be within the natural level of abundance or variability for prey species relative to predator demands (Table 4.1-7).

- **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). For example, before full observer coverage began in the late 1980s, the herring bycatch in BSAI trawl fisheries, principally those targeting pollock, may have been 8,000 to 10,000 tons (7,300 to 9,100 mt) per year (ADF&G 2003a). Past fishing pressures may also exert a persistent effect on these species, particularly on GOA capelin populations (Section 3.10.3). 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 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 still exist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will remove an annual increment of pelagic forage biomass. Herring harvested for sac roe have averaged about 50,000 tons (45,500 mt) per year, and the commercial catch of herring for bait averages about 8,000 tons (7,300 mt) per year. 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 the threshold level (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. Because the State of Alaska has not established annual harvest assessment programs for subsistence fisheries other than salmon, there is little monitoring of subsistence fish harvests, and annual statewide catch data are not compiled (ADF&G 2001). 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 Exxon Valdez disaster of 1989 suggests that a large petroleum spill coinciding in space and time with herring or capelin spawning, would most likely produce population declines and other adverse effects on pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, would be likely to affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability would occur in the event of a large petroleum spill. The conditions under which this effect would be significant relate to the areas affected and seasonal timing of the spill. If these events coincide with spawning locations and times, a significantly adverse cumulative effect on pelagic forage availability would most likely result. Additive or interactive contributions from State of Alaska commercial fisheries and subsistence fish harvests are not expected to be significant. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The direct/indirect effects of the spatial/temporal concentration of fishing effort under FMP 1 on pelagic forage availability are expected to be insignificant. FMP 1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial/temporal allocation of TAC of pollock and Atka mackerel, which have been determined to result in an insignificant impact on the spatial/temporal concentrations of fishing efforts on forage species (Section 4.5.11).

- **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 been shown to affect recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects 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 is mainly inshore, overlap with the groundfish fishery will more likely be 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 Exxon Valdez disaster of 1989 suggests that a large petroleum spill, coinciding in space and time with herring or capelin spawning, would most likely produce population declines, and adverse effects on 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.** 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 large-scale petroleum spill, forage fish populations could be significantly depressed as 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 in ways that might reduce or intensify this potential cumulative effect.

Removal of Top Predators

- **Direct/Indirect Effects.** The implementation of FMP 1 is predicted to have insignificant effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This alternative would not impair the continued recovery of whale populations, which are still reduced due to direct take in the past. Levels of seabird and marine mammal bycatch in the groundfish fisheries would not lead to listing any of these species or preventing recovery under the ESA. Because there is little available information on shark bycatch and current population status, the direct/indirect effects of this alternative on sharks are rated as unknown.

- **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 (Sections 3.5.3 and 4.5.3), seabirds (Sections 3.7.1 and 4.5.7), and marine mammals (Sections 3.8 and 4.5.8). Historical whaling, particularly 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 4.5.8). 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 level. Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have had a sustained effect on some populations that persists today (Section 3.10.1). 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 portion of the Pacific halibut population, a top predator (Section 4.5.2). The current policy is likely to continue in the 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 NPO 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 Section 3.7. The State of Alaska directed groundfish fisheries 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 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 petroleum spill at sea could result in the 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 primarily from continued high levels of seabird bycatch by NPO longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, it is likely that the present high levels of seabird bycatch will continue in the future. The conditions under which this cumulative effect could be significant include the continuation of high external seabird bycatch rates in conjunction with a large petroleum 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 could intensify or reduce the potential cumulative effect by influencing recruitment.

<u>Introduction of Non-Native Species</u>

- **Direct/Indirect Effects.** Under FMP 1, total catch (target and nontarget species) would decrease by less than one percent in the BSAI and increase by about 12 percent in the GOA relative to the baseline (Table 4.5-81). These catch levels indicate that this alternative would maintain about the same potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms that currently exists under baseline conditions. Therefore, the direct/indirect effect of FMP 1 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **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). In Washington State and British Columbia, Atlantic salmon (*Salmo salar*) have been farmed in floating saltwater net pens since the late 1980s, and deliberate releases of individual fish considered "non-performing" due to their sub-standard size total hundreds of thousands annually (ADF&G 2002a). Since first reports in 1990, there has been an increasing trend of incidental take of Atlantic salmon in the State of Alaska directed salmon fisheries (GOA), and the first specimen of an Atlantic salmon from the Bering Sea was captured in a bottom trawl south of the Pribilof Islands in 1997 (Brodeur and Busby 1998). 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 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 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 direct/indirect effects of FMP 1 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 1 would decrease by less than one percent in the BSAI and increase by about 20 percent in the GOA relative to the baseline (Table 4.5-81). These are still less than one percent of the total system energy as estimated from mass-balance modeling for the eastern Bering Sea. Therefore, estimated energy removals under FMP 1 would not have the potential to produce 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 correspondingly 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. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 6 percent of the cumulative biomass removed annually under this alternative (Table 4.5-82).The State of Alaska directed groundfish and subsistence fisheries would 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. However, these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features and are viewed as only partly comparable systems. Their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 1 is predicted to have an insignificant cumulative effect on energy removal in the reasonably foreseeable future. The total domestic groundfish catch under this alternative 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 1997-2001 average, the cumulative total catch of these external fisheries plus the BSAI and GOA groundfish fisheries will increase by about 6 percent over the estimated total catch for FMP 1 alone (Table 4.5-82). 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 4.5-82).

Energy Redirection

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 1 on energy redirection are expected to be insignificant. Projected trends in total discards modeled for FMP 1 show about a 5 percent increase in the BSAI and a 15 percent decrease in the GOA (Table 4.5-82). These effects would be small relative to the baseline and 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.** Because ecosystem energetics is a dynamic process, it is difficult to know whether past changes in energy cycling and in 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 prior to passage of the MSA. 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 they were 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 1 is predicted to have an insignificant cumulative effect on energy redirection. The cumulative effect of FMP 1, in combination with external sources, is not expected to depart significantly from the comparative baseline condition 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. 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.

Change n Species Diversity

- **Direct/Indirect Effects.** The expected direct/indirect effects of FMP 1 on species diversity are rated as unknown for skates, sharks, non-specified species and other species and insignificant for other groups. Under FMP 1, catch levels for target species, prohibited species, seabirds, and marine mammals would be insufficient to bring these species below minimum population thresholds. Forage species life history characteristics, along with the ban on initiating a forage fish fishery under this alternative, and maintaining closed areas that provide protection for HAPC biota (for example, corals) would help to prevent these species from falling below minimum population abundance thresholds. Further research will be required to assess whether FMP 1 bycatch levels for skates, sharks, non-specified species and other species, all poorly understood, will reduce species within these groups, thus, resulting in population-level impacts.

- **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 3.10.1.4). 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 species (including HAPC) are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to direct mortality as bycatch, but lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change (Section 3.7).

  As stated in Section 3.10.3, 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 positive correlations with prey abundance, and cyclic fluctuations in species abundance occurred in both fished and unfished species. It was concluded that in the eastern Bering Sea ecosystem, the trophic level of the harvest increased slightly since the 1950s and stabilized as of 1994, suggesting that the comparative baseline harvest levels are sustainable. These authors also concluded that the fish populations examined are stable. 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. Although commercial fishing has not been largely implicated in BSAI and GOA ecosystem changes, studies of other ecosystems with much greater fishing pressures indicate that fishing, in combination with climate change, can alter ecosystem species composition and productivity (Jennings and Kaiser 1998, Livingston and Tjelmeland 2000). Assessing the extent to which this has occurred in the BSAI and GOA ecosystems, or may occur in the future, will require further research.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC 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, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits. 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 enable introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 1, a conditionally significant adverse 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 could change species diversity in a negative 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, or be kept from recovering from levels already below, minimum biologically acceptable limits (Table 4.1-7).

<u>Change in Functional (Trophic) Diversity</u>

- **Direct/Indirect Effects.** Potential direct/indirect 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 one another in response to environmental stressors, thereby maintaining the structure of the food web. Under FMP 1, the predicted direct/indirect effects of the groundfish fisheries on trophic diversity are rated as insignificant, because they are expected to be similar to the comparative baseline conditions (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.

- **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 (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 1 could produce a conditionally significant adverse effect on trophic diversity. The primary condition for this effect is largely speculative. A climatic regime shift could make a trophic guild containing one or more target species more vulnerable to fishing pressure. A regime shift in the future, similar to well-documented examples that have occurred in the past (Sections 3.3 and 3.10.1.5), could decrease species diversity within a trophic guild by reducing the productivity or shifting the distributional range of one or more member species. If this climatic effect went undetected and without compensatory adjustments to fishing effort, the continued removal of particular target species, especially slow-growing species such as rockfish, could decrease their representation within trophic guilds.

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to structural habitat diversity is 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. In FMP 1, the species composition and amounts of removals, bottom gear effort and bycatch amounts of HAPC biota, and areas closed to trawling relative to coral distribution are relatively similar to the baseline. Therefore, the change from baseline condition that would result from this alternative is evaluated as insignificant with respect to structural habitat diversity. Some of these organisms have physical characteristics and life-history traits that make them sensitive to fishing removals. The very long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. It is important to ensure that the spatial distribution of areas closed to bottom fishing is broad enough, relative to coral distribution, to allow the corals to fulfill their functional role. Present trawl closures protecting Steller sea lion habitat 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 1 would be similar to the comparative baseline conditions, they might not be sufficient to provide protection to these sensitive organisms.

- **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-managed scallop fishery employs bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. In addition, a large petroleum spill 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.** Direct/indirect effects of FMP 1, rated insignificant, could contribute to a conditionally significant adverse cumulative effect on structural habitat diversity under any of the following three conditions. First, the additive effect of the scallop fishery, employing bottom dredges, could add to the effects of bottom trawling by the groundfish fishery 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 and/or distribution of bottom-dwelling invertebrates that provide structural habitat.

<u>Change in Genetic Diversity</u>

- **Direct/Indirect Effects.** If FMP 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 the comparative baseline conditions. Consequently, the effect of the groundfish fisheries on genetic diversity would be insignificant under this alternative. However, because genetic diversity remains unknown for most species, the potential direct/indirect effects of fishing 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, 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 determined in the absence of current conditions. Heavy exploitation of certain spawning aggregations occurred 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 cumulatively 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, belugas, 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 make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 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. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries.

4.5.11 Summary of Alternative 1 Analysis

The direct, indirect, and cumulative ratings for all resource categories analyzed under this alternative are summarized in Tables 4.5-83 through 4.5-89.

Table No.	Resource Category	Components	Section 4.5 Reference
4.5-83	Target Groundfish Species	BSAI and 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	4.5.1
4.5-84	Prohibited, Other, Forage and Non-specified Species	Pacific Halibut, Pacific Salmon and Steelhead Trout, Pacific Herring, Crab Other Species Category Forage Fish Category Grenadier	4.5.2 4.5.3 4.5.4 4.5.5
4.5-85	Habitat	BSAI, GOA	4.5.6

Table No.	Resource Category	Components	Section 4.5 Reference
4.5-86	Seabirds	Black-footed Albatross, Laysan Albatross, Short-tailed Albatross, Northern Fulmar, Shearwaters, Storm-petrels, Cormorants, Spectacled Eider, Steller's Eider, Jaegers, Gulls, Kittiwakes, Terns, Murres, Guillemots, Murrelets, Auklets, Puffins	4.5.7
4.5-87	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	4.5.8
4.5-88	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) 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 U.S. Consumers (Product Quantity, Product Year-Round Availability, Product Quality, Product Diversity) Non-Market Goods (Benefits Derived from Marine Ecosystems and Associated Species)	4.5.9.1 4.5.9.2 4.5.9.3 4.5.9.4 4.5.9.5 4.5.9.6 4.5.9.7
4.5-89	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	4.5.10

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