CHAPTER 3

Affected Environment

This page intentionally left blank

Chapter 3 Affected Environment

This chapter describes the physical, biological, and socioeconomic resources of the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) and the ecosystems of the eastern Bering Sea and northeastern North Pacific Ocean. These descriptions present the relevant history, natural history, and current status of the groundfish resources and their environments and are intended to establish an environmental baseline that will serve as a starting point for the direct, indirect, and cumulative effects analysis to come in Chapter 4.

This chapter begins by explaining the approach and methods that have been used in gathering and presenting this information and by discussing the methodology used to analyze the environmental and socioeconomic effects of past amendments to the current BSAI and GOA groundfish fishery management plans (FMPs).

3.1 Approach and Methods

The current status of any given resource is the result of the interplay between many natural events and human actions and influences over time. An analysis of cumulative effects on a resource must necessarily begin by identifying the events and actions that have affected the resource in the past and continue to exert an influence in the present. To this end, the present chapter describes each resource, reviews historical trends, and conducts a past/present effects analysis of the actions and events that have altered the resource from its original, pre-development condition. These descriptions, reviews, and analyses combine to form a baseline that represents current conditions of the resources and environment of the groundfish fisheries in the Economic Exclusion Zone (EEZ) off Alaska. This baseline will serve as the starting point for the direct, indirect, and cumulative effects analyses to come in Chapter 4.

The methods described below comply with Council on Environmental Quality (CEQ) guidance for scoping and organizing processes associated with cumulative effects analyses (CEQ 1997), as well as United States (U.S.) Environmental Protection Act (EPA) guidance for the consideration of cumulative effects (EPA 1999). The reader should refer to Section 4.1.4 for a comprehensive description of how the past/present effects analyses feed into the direct, indirect, and cumulative effects analyses in Chapter 4.

3.1.1 Scoping

Scoping defines the issues, actions, and geographic and chronological boundaries for the past/present effects analyses. The scoping process for the analyses of this chapter has entailed the following:

- Reviewing public and agency comments;
- Identifying the issues and events connected with the groundfish fisheries since their implementation;
- Identifying internal Magnuson-Stevens Fishery Conservation and Management Act (MSA) management actions and their potential effects (see Section 3.2 for a discussion of this analysis)
- Identifying issues and events (natural and human-influenced) external to the groundfish fisheries; and
- Identifying management actions external to the MSA process and their potential effects.

The overall geographic scope of the analyses has been broadly defined as the Bering Sea and North Pacific Ocean. This broad geographic scope was necessitated by the transboundary movements of a number of fish species. Such a broad area, however, is not relevant to all resource categories discussed in this section. When the overall geographic scope is not applicable to a given resource, a relevant geographic sub-area in the analysis of that particular resource is defined. Likewise, when events outside the overall geographic scope have strongly influenced the baseline condition for a given resource, such as with some migratory seabirds and marine mammals, an extended geographic scope for analysis of effects on that resource is defined.

EPA guidance (1999) recommends establishing a chronological reference point to mark the beginning of a historical review, or past effects analysis. For our present purposes, that environmental reference point in time is defined as 1740, one year prior to first contact of non-indigenous people. This assumes that at that time the BSAI and GOA ecosystems existed in an ecologically sustainable condition; hence, the environmental reference point of 1740 is a logical starting point for the ecosystem discussion. The overall time frame for the past/present effects analyses thus spans the period from 1740 to 2002. For many of the resources under consideration here, however, the lack of data requires that the discussion use a later point in time as a starting point. In these cases, the relevant environmental reference point in each particular analysis is defined.

3.1.2 Organizing

The organizing step characterizes and consolidates the issues and actions defined during the scoping process. The following steps have been taken to organize the information of this chapter accordingly:

- Identifying the relevant physical, biological, and socioeconomic resources;
- Reviewing the literature, personal communications with resource specialists, and documentation of available information on identified resources (i.e., descriptive, trend, and impact information);
- Identifying indicators for direct/indirect effects that could cause population and/or ecosystem level effects to occur;
- Conducting a past/present effects analysis; and
- Defining a baseline condition for identified resources.

3.1.3 Identifying Effects, Events, and Actions

A cumulative effects analysis takes into account the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (40 Code of Federal Regulations [CFR] 1508.7). For the purposes of this Programmatic Supplemental Environmental Impact Statement (SEIS), the definition of other actions includes human-controlled, natural, and climatic events.

To identify direct/indirect effect indicators and external events and management actions, we have produced a comprehensive checklist for each resource category. Information presented in the checklists was obtained from reviewing environmental impact statements (EIS), reports and resource studies, peer-reviewed literature, and from conferring with expert contributors to the Programmatic Supplemental Environmental Impact Statement (SEIS). The checklists have been entered into the administrative record.

Direct/Indirect Effect Indicators

Direct/indirect effect indicators are specific to each resource category and are presented in the past/present effects analysis for each resource.

Past/Present External Events and Actions

The detailed checklists identified the following human-controlled external event and action categories and natural and climatic events relevant to the past/present effects analysis:

- past and present foreign fisheries (inside the U.S. EEZ prior to the MSA and, after passage of the Act in 1976, outside the EEZ). Appendix B of this document provides a detailed discussion of the historical foreign fisheries and pertinent management actions:
- fisheries managed by the International Pacific Halibut Commission (IPHC);
- fisheries managed by the State of Alaska;
- Native Subsistence Fisheries;
- Commercial Harvesting of Marine Mammals and Seabirds;
- Subsistence Hunting of Marine Mammals and Seabirds;
- Pollution and Toxic Contamination, including the Exxon Valdez Oil Spill (EVOS);
- Introduction of Mammalian Predators to Seabird Colonies;
- Natural Events and Phenomena; and
- Long and Short term Climatic Events.

Internal Events and Actions

These include post-Magnuson-Stevens Act foreign fisheries inside the U.S. EEZ, Joint Venture fisheries, and domestic fisheries. Management actions include the BSAI and GOA FMPs and associated amendments. Also included are the Endangered Species Act (ESA) Section 7 consultations (Biological Opinions) of National Marine Fishery Service (NMFS or National Oceanic and Atmospheric Administration [NOAA] Fisheries) and the U.S. Fish and Wildlife Service (USFWS), and the resulting Reasonable and Prudent Alternatives that have been implemented to protect endangered or threatened species. Appendix B of this document provides a detailed discussion of the evolution of the fisheries management plans in use today an analysis of FMP amendment actions.

3.1.4 Past/Present Effects Analysis

A two-tier table structure is used for summarizing the written discussions and for organizing the information used in the cumulative effects analyses. For each resource, a first table organizes the information from the

past/present effects analysis used in defining baseline conditions for a resource. This baseline information then feeds into a second table, which is the cumulative effects table. Chapter four will provide a detailed discussion of the cumulative effects tables. The first-tier, past/present effects tables are explained below.

The main column headings in the past/present effects analysis table are as follows:

Direct/Indirect Effect

Effects identified for each resource that have the potential to cause population and/or ecosystem level effects are listed.

- **Past/Present Events:** Events that produce or have the potential to produce the identified direct/indirect effects, listed in relation to direct/indirect effects listed in the first column. This column heading is further divided into two sub-columns:

  – External: Natural, climatic, and human controlled events and actions not directly associated with management of the groundfish fisheries;

  – Internal: Events and actions directly associated with management of the groundfish fisheries;

- **Past/Present Management Actions:** Management actions that regulate the events, listed in relation to the direct/indirect effects listed in the first column. This column heading is further divided into two sub-columns:

  – External: actions self-imposed by management and industry related to the direct/indirect effects listed in the first column and not directly associated with management of the groundfish fisheries);

  – Internal: Management actions related to the direct/indirect effects listed in the first column and directly associated with groundfish fisheries management.

In addition, a text box is provided with each past/present effects table that summarizes the comparative baseline of a resource. All of the information in the past/present effects tables is also discussed in each resource category sub-section.

3.2 Assessment of the Fishery Management Plan Amendments

The BSAI and GOA FMPs were implemented in 1979 and 1981, respectively. Since that time, the BSAI FMP has been amended 65 times, and the GOA FMP has been amended 55 times. Each FMP amendment was supported by the required level of analysis under National Environmental Policy Act (NEPA), EO 12866, and the Regulatory Flexibility Analysis. As part of the programmatic review of the groundfish fisheries, however, it is necessary to review the cumulative impacts of the groundfish fisheries on the human environment, including both the incremental impacts of the FMP amendments, and the impact of groundfish fishery management in addition to other past external impacts on the environment affected by the groundfish fisheries, in order to establish a baseline condition against which to compare the Programmatic SEIS alternatives for direct, indirect and cumulative effects.

A description of the nature of the fisheries and the lingering influences of pre-Magnuson Act fisheries in the North Pacific is discussed in detail in Appendix B. Other ongoing external influences on the human environment that may be impacting synergistically with the groundfish fisheries are discussed in later sections of Chapter 3. Regulatory amendments, which regulate the fisheries within the guidelines of the amended FMPs, are summarized in Appendix E. This section deals specifically with the incremental amendments to groundfish fishery management. Section 3.2.1 describes the management actions contained within the BSAI and GOA amendments. Section 3.2.2 provides a description of the FMP amendments and their objectives, implementing regulations, and results. Section 3.2.3 assesses the cumulative past effects of similar management actions in order to determine whether an impact occurred, and if so, whether it was adverse or beneficial. This evaluation is an important element in assessing the baseline condition for the groundfish fisheries.

3.2.1 Fishery Management Plan Amendments

The management measures implemented through the BSAI and GOA FMPs, and their amendments, are categorized and summarized in Tables 3.2-1 and 3.2-2 for the BSAI and GOA, respectively. The management actions have been grouped into six categories: management and monitoring, groundfish yield/sustainability, bycatch and incidental catch, habitat conservation, seabird and marine mammal conservation, and socioeconomic issues. Many of the amendments initiate multiple management changes, and the amendment number may appear in more than one category. However, each specific measure only appears once in the table. The categorization is based on the primary objective of the management action. That is, although a particular management action may have achieved a secondary objective of providing incidental benefits for habitat conservation, if the primary intent of the action (as stated in the supporting analysis) was to control bycatch, the management action is listed in the 'Bycatch and Incidental Catch' category.

- Management and Monitoring
  - To continue authorization of the groundfish fisheries;
  - to establish a structured process for administering groundfish fisheries;
  - to correct inefficiency in administration of the fishery management process;
  - to make the management process more understandable to users;
  - to help facilitate enforcement of fishery regulations;
  - to enhance data collection and record keeping;
  - to improve reporting; and
  - to clarify the intent of past regulations.

- Groundfish Yield/Sustainability
  - To protect target groundfish stocks;
  - to ensure productivity of groundfish stocks;
  - to control the rate of groundfish harvest;
  - to maintain long term yield from groundfish stocks;
  - to improve the quality of groundfish products; and
  - to protect groundfish habitat.

- Bycatch and Incidental Catch
  - To reduce discards to the extent practicable;
  - to minimize the incidental catch of non-target groundfish species, undersized target groundfish, and prohibited species;
  - to avoid waste of marine resources;
  - to facilitate full utilization of catches taken in groundfish fisheries; and
  - to avoid gear loss and subsequent "ghost fishing" of lost gear.

- Habitat, Seabird and Marine Mammal Conservation
  - To reduce fishing gear effects on the marine environment;
  - to avoid fishing effects on marine mammals, birds, or habitat areas of critical concern;
  - to avoid disturbance, injury, or mortality to marine mammals or seabirds; and
  - to protect marine mammal and seabird food sources.

- Socioeconomic Issues
  - To manage effort in groundfish fisheries;
  - to make prosecution of groundfish fisheries more fair to user groups;
  - to avoid gear conflicts, gear entanglement, or gear damage; and
  - to enhance safety at sea.

3.2.2 Description of Fishery Management Plan Amendments, Objectives, Implementing Regulations, and Results

A detailed summary of the amendments to the BSAI and GOA FMPs is contained in Appendix C (BSAI FMP amendments) and Appendix D (GOA FMP amendments). The amendments are listed numerically, and for each, the following information is included: the dates of decision-making and implementation, the purpose and need of each amendment, a summary of implementing regulations, a description of the supporting analysis and a statement of the results of the amendment.

3.2.3 Cumulative Past Effects of Fishery Management Plan Amendments

The following section summarizes the results of the historical review of the North Pacific fishery management incremental decision-making process. The FMP amendments are assessed below in two ways. Section 3.2.3.1 examines the FMP amendment actions by determining the degree to which they were effective at resolving the stated management objective. Section 3.2.3.2 summarizes the impact of the FMP amendments on particular resources or resource categories, and directs the reader to the more detailed analysis of the contribution of groundfish fishery management since the implementation of the FMPs to the comparative baseline condition of the resources in question.

FMP amendments are denoted in the following manner: GOA FMP Amendment 10 is listed as GOA 10.

3.2.3.1 Fishery Management Plan Amendments Assessed by Management Objective

As described in Section 3.2.1, the historical FMP amendments have been organized into six categories based on the objective of the management action: management and monitoring actions, groundfish yield and sustainability actions, bycatch and incidental catch actions, habitat actions, seabird and marine mammal actions, and socioeconomic actions. The BSAI and GOA FMP amendments are assessed below in terms of their efficacy in achieving the management objective and mitigating adverse effects of groundfish fishery prosecution.

Management and Monitoring Actions

Various GOA and BSAI FMP amendments implemented administrative changes. GOA 1, 7, and 8 extended the GOA FMP, eventually eliminating the expiration date. GOA 16 and 34 corrected previous FMP language. GOA 14, 15, and 18 and BSAI 1, 11, 12, 13, and 21 added framework measures to remove the setting of target quotas, incidental catch and prohibited species catch (PSC) limits, and fishing season dates from the FMP amendment process, and to conform the GOA FMP with the BSAI FMP. GOA 21 and BSAI 16 established procedures for setting interim total allowable catch (TACs) so that the fisheries could open on January 1. Since these actions provided for more effective fishery management, they are considered to have had a non-conditional beneficial effect on the groundfish fisheries.

Clarifications and definitions of terms and standards are also management actions that form part of the FMP amendments. Target and prohibited species are defined in GOA 16 and 21 to be consistent with the BSAI FMP. GOA 14, 16, 21 and 24 and BSAI 9, 16, and 19 also specify and define legal gear, and clarify directed fishing definitions. GOA 21, 44 and 56, and BSAI 16, 44 and 56 define overfishing levels for the groundfish fishery resources, allowing for improved conservation of target groundfish stocks. Additionally, GOA 15 revised the goals and objectives for the GOA FMP. Unambiguous standards, definitions and policies assist the efficient prosecution of the groundfish fisheries, and are considered to have had a beneficial effect.

The GOA and BSAI FMPs, GOA 4, 11, 14, 15, 16, 17, and 18, and BSAI 9, 10, 11a, 12, and 13 established and revised recordkeeping and reporting requirements for vessels participating in the groundfish fisheries. The GOA and BSAI FMPs included provisions for observers on foreign fishing boats while GOA 18 and 30 and BSAI 10, 13, 27, and 37 initiated and redefined the domestic fisheries observer program. Data from catch and observer reports are important components of the fisheries management processes. Therefore, the establishment of these programs and their continuing implementation are considered to have had a non-conditional beneficial effect on the groundfish fisheries.

Various GOA and BSAI FMP amendments were intended to increase the ability of managers to respond quickly to situations to resolve gear conflict issues or for conservation purposes. The GOA FMP, GOA 8 and 15 and BSAI 1, 10, 16a, 19, 21 and 24 all authorize the NOAA Fisheries Regional Administrator to use inseason management measures react responsively to fishery issues. The intent of these actions, the issuance of rapid field order in response to newly developing issues, has not been necessarily been fulfilled, however to the extent that it has allowed flexibility in management these actions are considered beneficial.

The original GOA FMP, GOA 22, and BSAI 17 allowed the issuing of experimental fishing permits for the purpose of testing gear efficiency, fishing techniques, bycatch mortality reduction techniques, and other

methodologies. It is inferred that information gained from activities conducted under experimental fishing permits leads to gains in the effectiveness of the groundfish fisheries. Therefore, these actions are considered to have had a conditionally beneficial effect on the groundfish fisheries.

Groundfish Yield and Sustainability Actions

The BSAI and GOA FMPs establish annual harvest levels for groundfish species. For foreign fishermen, exceeding a nation's allocation in a management area or district triggered closure of that area to fishermen from that nation. These actions are considered beneficial as they prevented overfishing of the stocks by foreign fishermen.

The GOA FMP establishes optimum yield (OY) levels for each groundfish species, with revisions to squid, Atka mackerel, Pacific cod, pollock, sablefish, 'other rockfish', and 'other species' determinations made in GOA 4, 7, 10, 11, 13, 14. Available data on stock biomass indicated that the given target groundfish stocks were appropriate. Therefore, these actions are considered to have had a neutral to beneficial effect on the given target groundfish stocks. As discussed in the Management and Monitoring Actions above, GOA 15 revised the process for setting target species quotas, resulting in the establishment of an OY range, and an annual TAC-setting process implemented by regulatory amendment. Harvest levels were established in the BSAI FMP also, however BSAI 1 established a multi-year, multi-species OY (a range from 1.4-2.0 million mt) for the BSAI groundfish complex as a whole. Prior to the implementation of this amendment, BSAI 4 adjusted the Pacific cod harvest levels from the harvest levels set in the BSAI FMP. The TAC framework has had a beneficial impact due to the increased management flexibility, and the incorporation of an annual status of stock review that sets catch quotas based on the best available science.

The GOA and BSAI FMPs managed specific species targeted by the groundfish fisheries, and identified requirements for some incidentally caught species (see prohibited species discussions in Bycatch and Incidental Catch Actions below). Various FMP amendments made alterations to the management categories identified in the FMPs. GOA 5, 7, and 8 established new management categories for grenadiers, and for idiot rockfish, and non-specified species. GOA 14 gave the Secretary of Commerce the authority to split or combine species within the target species category. GOA 31 established Atka mackerel as a separate target species category. BSAI 12 established a separate rock sole target species category separate from the 'other flatfish' category. Since these actions provided for more species-specific management and thus reduced the risk of overfishing the stocks, they are considered to have had a beneficial effect.

The GOA FMP apportioned quota over five subareas, which were reduced to three by GOA 4. GOA 8, 11 and 22 divided and modified the eastern GOA districts for sablefish management. GOA 13 combined the western and central management areas for pollock allocations. GOA 14 created a new regulatory district for 'other rockfish', and recognized the State of Alaska management areas for demersal shelf rockfish. GOA 18 and BSAI 17 established the Shelikof District in the GOA (which was rescinded in favor of other measures in GOA 25 as part of Steller sea lion protection measures) and the Bogoslof district in the Bering Sea, respectively, in order to manage the fisheries' catch of spawning pollock. GOA 4, 8, and 22 modified the GOA regulatory districts. BSAI 28 divided the Aleutian Islands subarea into three management districts for the immediate purpose of spatially allocating Atka mackerel in order to address localized depletion. The creation of subareas and species-specific districts has allowed managers to control for uneven exploitation and is considered beneficial.

GOA 21 and 46 deferred demersal shelf, blue, and black rockfish management to the State of Alaska. The management shift is considered to have had a conditionally beneficial effect, since State management has allowed more consistent management of these species throughout Federal and State waters, minimizing the risk of localized depletion and the possibility of exceeding TAC.

GOA 19 and BSAI 14 allocated the pollock TAC seasonally, over four seasons in the GOA and two in the BSAI, in order to reduce the potential for fishing on spawning aggregations to adversely impact the sustainability of the stock. Limiting the amount of quota available during spawning seasons is effective at reducing fishing on spawning populations, although it also decreases the value of the fishery.

GOA 10, 32, and 38 were conservation measures taken to rebuild depressed Pacific ocean perch stocks. These measures were implemented specifically to conserve stocks, and have succeeded at rebuilding the Pacific ocean perch stocks. They are therefore considered to be beneficial.

Bycatch and Incidental Catch Actions

Species that must be discarded at sea are specified in the GOA and BSAI FMPs, and limits on the catch of these prohibited species are established in the FMP amendments as a way to minimize the bycatch and encourage the use of more selective gear. Once a limit is achieved, a closure is triggered, either of a fishery or fisheries, or a specified fishing area. GOA 14, 15, 18, and 21 specify halibut PSC limits for the GOA groundfish fisheries, and apportion them by season and gear. BSAI 1a, 3, 8, 12, 12a, 16, 19, 25, 37, 40, 41, 57 and 58 all establish or modify PSC limits in the BSAI for halibut, crab, salmon and herring, by sector and fishery. It is inferred from the fact that PSC limits have been consistently used as a bycatch management tool, and have been extended from applying only to halibut, to being set for most prohibited species in the BSAI, and that the limits have consistently decreased over the years, that they are successful in decreasing the bycatch of these species in the groundfish fisheries. As a result, these actions are considered beneficial in minimizing the impact of the groundfish fisheries.

Many measures identify gear specific closure areas to reduce bycatch. The GOA and BSAI FMPs, GOA 9 and 10, and BSAI 4, 7 and 10 specified foreign bottom trawl and trawl closures to reduce crab and halibut bycatch. Although GOA 4 and BSAI 1 exempted the domestic fleet from some of the domestic bottom trawl restrictions in the GOA and BSAI FMPs, GOA 15, 18, 26 and 60 reinstituted specific non-pelagic trawl prohibitions around Kodiak and in Cook Inlet to lower bycatch of crab species. BSAI 10, 12a , 21a, 35, 37, 40, and 57 established restricted seasonal, year-round or PSC limit-triggered areas to decrease crab bycatch. BSAI 10, 12a, 16a, and 57 established protections to lower the bycatch of halibut. BSAI 1a, 3, and 8 were early measures to reduce salmon PSC limits over time, as referred to above, whereas BSAI 21b, 35, and 58 attempted to address salmon bycatch using trigger amounts and area closures. BSAI 16 established herring savings areas. It is inferred that these measures improved the efficiency of groundfish harvest and as a consequence decreased the incidental take of species in bottom trawls. Therefore, these measures are considered to have had a conditionally beneficial effect.

Various other measures are adopted to control bycatch and incidental catch. GOA 24 and BSAI 19 delayed the start of the groundfish trawl fisheries in order to avoid excessive bycatch. Also, GOA 45 adjusted the seasonal pollock allowance schedule in order to avoid high salmon bycatch in the summer months. Bycatch reduction was also encouraged through gear modifications. GOA 21 and FMP 16 required halibut excluder devices on pots, and FMP amendment actions were also specifically implemented to reduce ghost fishing by

lost gear. GOA 8 and 21 and BSAI 16 required biodegradable panels on sablefish pots. Any reduction in ghost fishing or increase in gear selectivity is considered to have a conditionally beneficial effect.

Additionally, incentive programs were introduced in GOA 21 and 24 and BSAI 16 and 19 to penalize vessels with excessive bycatch. Vessel sanctions under the incentive programs have proved very difficult to enforce, and these actions have not achieved bycatch reductions in the groundfish fisheries.

Another goal of bycatch-related measures is the minimization of waste. BSAI 11 minimized, by splitting the annual joint venture pollock quota into two seasons, and GOA 19 and BSAI 14 prohibited roe stripping of pollock in the groundfish fisheries, both encouraging greater utilization of fish fit for human consumption, and mitigating the potential for overharvest of spawning stocks to affect the sustainability of the pollock resource. BSAI 26 and 50 and GOA 29 and 50 were implemented to reduce post-harvest waste of incidentally-caught Pacific halibut and salmon in specified groundfish fisheries by donating the bycatch to social service food banks. Since Pacific halibut and salmon bycatch would typically be discarded in federal waters, these actions provide the needy public with a non-conditional beneficial effect. The retention of Pacific halibut and salmon bycatch also provides an additional opportunity to collect biological samples and scientific data to support long-term solutions to bycatch of these species. Therefore, these action are also considered to have had a non-conditional beneficial effect on groundfish fisheries.

GOA 49 and BSAI 49 were implemented to reduce discards in the groundfish fisheries, and encourage full utilization. The amendments required 100 percent retention of pollock and Pacific cod, and for rocksole and yellowfin sole as of January 1, 2003, regardless of how or where the fish were caught unless the fish were unfit for human consumption. These measures, beginning in 1998, have dramatically reduced the discard rates of pollock and Pacific cod. Therefore, they are considered to have had a conditionally beneficial effect on groundfish fisheries. BSAI 75 repealed the implementation of Improved Retention/Improved Utilization (IR/IU) for flatfish due to the excessive cost it would have imposed on those fishermen. As IR/IU was never implemented for flatfish, this action is considered to have had no effect.

Habitat Actions

GOA 14 and 55 and BSAI 9 and 55 defined and established habitat protection policies for the future conservation of groundfish stocks. GOA 55 and BSAI 55 also identified and described essential fish habitat for species managed under the FMPs, and habitat areas of particular concern were identified as living substrates in shallow and deep waters, and freshwater habitats used by anadromous fish. To the extent that such policies increase awareness of sensitive habitat and influence other management decisions, they have provided a conditionally beneficial effect to marine habitat. However, no concrete measures were proposed in conjunction with these FMP amendments to mitigate adverse habitat impacts from fishing activities.

GOA 59 established the Sitka Pinnacles Marine Reserve encompassing a 2.5 square nautical miles (nm^2) area off the Cape Edgecumbe pinnacles as a protected area for rockfish and lingcod habitat. This action is anticipated to be beneficial to these long-lived, vulnerable species.

Seabirds and Marine Mammal Actions

Forage fish (e.g., capelin, eulachon, and sand lance) are an important food source for seabirds and marine mammals. GOA 39 and BSAI 36 prohibited the establishment of a commercial fishery targeting forage fish,

thereby preserving the food resource. These FMP amendments are considered to have had a conditionally beneficial effect on seabirds and marine mammals.

Several FMP amendments have been implemented specifically for the direct protection and conservation of marine mammals. No-fishing buffer zones were established around rookeries and haulouts deemed critical to walrus (BSAI 13 and 17) and Steller sea lions (BSAI 20 and GOA 25). GOA 25 also modified pollock management districts in the western/central GOA, with a view to reducing the effects of prey competition from the groundfish fisheries. While the impact of the fisheries on walrus has not reasserted itself as a problem, the population levels of the western stock of Steller sea lions continued to decline even after the protection measures adopted in GOA 25. Further protection measures have been implemented by emergency rules and regulatory amendments since 1999, however the degree to which the Steller sea lion population levels are impacted by the groundfish fisheries is still a matter of scientific controversy. As such, the effect of the FMP amendments relating to Steller sea lion protection measures cannot be determined.

Socioeconomic Actions

The establishment of groundfish quotas and spatial and seasonal allocation is further discussed under Groundfish Yield and Sustainability Actions above.

The GOA and BSAI FMPs established specific allocations for foreign and domestic fisheries, with reserves providing for growth of the domestic fisheries. The program was modified in GOA 7, 8 and 11, and GOA 2 and 6 and BSAI 2 and 4 increased domestic groundfish quota and correspondingly decreased foreign allocations. To the extent that the MSA called for domestication of the fisheries, the amendments were beneficial in promoting domestic groundfish harvests. The establishment of foreign closure areas, particularly in areas likely to be utilized by domestic fishermen (such as the Aleutian Islands and Southeast Alaska) under the FMPs, was also effective in preventing gear conflict between domestic and foreign fishermen and promoting domestic fisheries (although certain foreign and domestic restrictions were relaxed in GOA 4 after they were found to be unnecessary).

The GOA and BSAI FMPs specified allocations between gear types for foreign fishers. Management measures favoring foreign longliners were adopted in GOA 3, which modified restrictions on foreign Pacific cod quota in the Chirikof district in order to allow the foreign longline fleet to take a higher percentage of the allocated foreign quota, and GOA 4, which separated longliners from trawlers for quota closures. The greater selectivity of longline gear over trawl gear resulted in beneficial impacts on bycatch rates and habitat.

Allocation by gear type was first adopted for the domestic fisheries in GOA 14. In order to address excess capacity in the sablefish fishery, fixed allocations were assigned over a four-year adjustment period, to longline, trawl, and pot fisheries, with pot fisheries being phased out of the GOA sablefish fishery by the end of that time. Additionally, the amendment delayed the sablefish fishery start date to allow smaller vessels more opportunity to participate in the fishery. The FMP amendment slowed the growth in capacity and diminished the possibility of gear conflicts and grounds preemption, but did not solve the problem of overcapacity in the fishery.

The sablefish fishery was further modified by GOA 20 and BSAI 15, which implemented the sablefish Individual Fishing Quota (IFQ) program and eliminated the derby-style fishing associated with these fisheries. While the framework of the IFQ program was set out in GOA 20 and BSAI 15, modifications were made to ownership, transfer and processing restrictions in GOA 35, 36, 37, 42, 43, 54, and 64 and BSAI 31,

32, 33, 42, 43, 54, and 72. The sablefish IFQ program has been successful in diminishing the number of participants in the sablefish fishery, and has also succeeded at reducing bycatch, particularly of Pacific halibut, improving safety, reducing gear conflicts and fishing mortality due to lost gear, and increasing the economic value of the fishery.

Quota allocation between gear types continued to be used to address socioeconomic issues in the groundfish fisheries. BSAI 34 allocated 2 percent Atka mackerel TAC in the eastern Aleutian Islands to jig gear, in order to promote a local, small vessel fishery without direct competition from the large, high-capacity trawl fleet. However, although the amendment was successful in creating a quota allocation for the jig gear fishery, the fishery has not taken advantage of the quota to harvest Atka mackerel, therefore the amendment has had no appreciable effect. BSAI 53 allocated shortraker/rougheye rockfish between trawl and non-trawl gear in the Aleutian Islands, as the potential overfishing of shortraker/rougheye by the trawl fleet was also threatening to close non-trawl fisheries, resulting in loss of economic opportunity. The gear allocation was successful in limiting the scope of the problem.

In the pollock fishery, allocation of quota was further divided between processing sectors, namely trawl catcher processors and trawl catcher vessels delivering to catcher processors (the offshore sector), and trawl catcher vessels delivering to inshore processors. BSAI 18 established a 35 percent/65 percent allocation of pollock between the inshore and offshore sectors, which was extended through 1998 in BSAI 38. BSAI 18, 38 and 51 also established, adjusted and extended the catcher vessel operational area, a designated area off of Dutch Harbor to which the offshore sector was allowed only minimal access. GOA 23 allocated 100 percent of GOA pollock to inshore processors, which allocation was extended in GOA 40, 51, and 61. The amendments were successful in preventing the grounds preemption that occurred in 1991 and prompted development of the inshore/offshore allocations.

BSAI 61 implemented the provisions of the American Fisheries Act (AFA), establishing sector and cooperative allocations of pollock. The amendment defined specific vessel and processor cooperative linkages, and defined 'sideboards' that limited the participation of AFA pollock vessels in other fisheries in the BSAI and the GOA (implemented in the GOA in GOA 61). BSAI 69 further modified the BSAI pollock cooperative program. The establishment of cooperatives, and the buyout of nine vessels participating in the pollock fishery, was considered beneficial as it served to reduce excess capacity in the BSAI pollock fishery, resulting in increased economic efficiencies.

In conjunction with the BSAI and GOA pollock inshore/offshore allocations, Pacific cod was also identified in GOA 23 with 90 percent allocated to inshore processors, and 10 percent to offshore processors. This allocation was extended in GOA 40, 51, and 61, through 2004. In the BSAI, Pacific cod was initially allocated by gear type in BSAI 24 between trawl, hook-and line or pot, and jig gear. BSAI 46 modified the percentage allocation between trawl and fixed gear, and extended the 2 percent jig allocation. The specific allocation to jig gear was beneficial in that it gave coastal communities a way to compete in the valuable fishery. However, the allocation is not fully utilized by the jig fleet. BSAI 64 further divided the fixed gear allocation between hook-and-line catcher processors, and hook-and-line catcher vessels, pot vessels, and vessels less than 60 ft LOA. In order to avoid a substantial number of new entrants into the Pacific cod fishery, BSAI 67 specified eligibility requirements and required a limited entry permit Pacific cod species and gear endorsement for participation in the Pacific cod fishery. To the extent that the amendment avoided excess capacity in the fishery, it is considered beneficial.

GOA 28 and BSAI 23 established a vessel moratorium on new vessels entering into the groundfish fisheries, and was supplemented in GOA 41 and BSAI 39 with a License Limitation Program (LLP) for participating groundfish vessels. This program was modified and extended in GOA 57 and 58 and BSAI 59 and 60. The moratorium and LLP have reduced excess capacity in the groundfish fisheries, and prevented further growth, resulting in a beneficial impact.

The Community Development Quota (CDQ) program was established in conjunction with the sablefish and Pacific halibut IFQ programs in BSAI 15, however, due to delays in the implementation of that program, the CDQ program was first actualized in the pollock fishery as a result of BSAI 18. The CDQ quota for sablefish was increased in BSAI 30. BSAI 38 and 45 extended the pollock CDQ allocation, and BSAI 39 established a multi-species CDQ program for all groundfish species managed under the BSAI FMP. This was subsequently modified in BSAI 66 which removed squid from the CDQ program in order to allow more efficient use of the small squid quota allocation. The CDQ program was created in order to provide fishermen who reside in western Alaska communities a fair and reasonable opportunity to participate in the groundfish fisheries, to expand their participation in nearshore fisheries, and to help alleviate the growing social economic crisis in these communities. The FMP amendments are considered beneficial in their impact on western Alaska communities, as they have created revenues and employment in many of the communities.

GOA 27 and BSAI 22 established gear test areas in the Bering Sea that could be used to ensure that gear was in working order prior to season opening dates. It is inferred that this action likely resulted in reduced gear loss and entanglement on the fishing grounds, which would increase economic efficiency and reduce adverse habitat and mortality impacts due to ghost fishing.

Vessel safety was addressed in the GOA FMP in GOA 16, which formally incorporated safety considerations in accordance with the MSA. The amendment had little effect, other than to reinforce fishery managers' awareness of vessel safety considerations in decision-making.

3.2.3.2 Fishery Management Plan Amendments – Assessed by Impact to Resource Category

Although adopted to achieve a particular management objective, the FMP amendments have had secondary and indirect impacts as a result of their implementation. The impacts of the FMP amendments on the resources or resource categories that are components of the human environment affected by the groundfish fisheries, are discussed in detail in the remainder of Chapter 3. Specifically, the contribution of internal groundfish fishery management and the amended FMPs is assessed as part of the analysis of the cumulative past effects influencing the baseline condition of each resource. This section provides a brief summary of the FMP amendment impacts, and includes a reference to the relevant section later in Chapter 3 for more detailed discussion.

Target Species

Since the implementation of TAC frameworking removed the adjustments and modification of OY from the need for an FMP amendment, the amendments relating directly to target species have primarily been allocative (allocating TAC among seasons, areas or gear types, or implementing rationalization programs for target species). These amendments result primarily in socioeconomic impacts, rather than affecting the sustainability of the stocks. Some amendments have directly impacted the stocks, however. For example, BSAI 14 and GOA 19 dispersed directed fishing on pollock spawning aggregations, and GOA 59 established a protection area for rockfish and lingcod habitat. Other amendments have also had ancillary impacts on target

stocks. These impacts are discussed in further detail in the species subsections in Section 3.5.1, under the headings relating to internal effects from foreign, JV and domestic groundfish fisheries from 1976 to the present.

Prohibited Species and Non-Target Species

Many amendments have been implemented since the original FMPs to minimize bycatch of target and non-target species. PSC limits, with triggered closures upon exceeding the limits, have been the most popular and effective method for addressing prohibited species concerns.

Other measures that were implemented for other reasons have had incidental benefits for non-target species. BSAI 13, 15, and 46 and GOA 3 and 20 increased apportionment of target groundfish quotas to the longline fleet, which equated to a decrease in bottom trawl quotas. It is inferred that these measures improved the efficiency of groundfish harvest and as a consequence decreased the incidental take of species in bottom trawls. Therefore, these measures are considered to have had a conditionally beneficial effect.

BSAI 13, 15, and 46 and GOA 3 and 20 increased apportionment of target groundfish quotas to the longline fleet, which equated to a decrease in bottom trawl quotas. GOA 12 prohibited the use of longline pot gear for the harvest of sablefish in favor of hook-and-line gear. It is inferred that these measures may have had offsetting results: decreased grenadier bycatch from bottom trawls, and increased grenadier and skate bycatch in the longline fishery. Therefore, these measures are considered to have had a conditionally neutral effect on grenadier and skate stocks.

The impact of the FMP amendments on prohibited species is discussed in detail in Section 3.5.2, under the individual species headings. The impact on non-target species is discussed in the species subsections in Sections 3.5.3, 3.5.4, and 3.5.5, under the headings relating to internal effects from foreign, JV and domestic groundfish fisheries from 1976 to the present (also referred to as post-MSA fisheries).

Habitat

Many FMP amendments, whose purpose was primarily to reduce bycatch or incidental take, or to address allocation issues, have, however, mitigated fishing impacts on habitat. GOA 3 and 20 and BSAI 15 increased apportionment of target fish quotas to the longline fleet, equating to a decrease in bottom trawl quotas. BSAI 10 and 21a and GOA 9, 15, 18, and 26 closed specific geographic areas to bottom trawling, primarily for the protection of prohibited species. The reduction of bottom trawling due to these measures could provide conditionally beneficial effects to benthic habitat in localized areas.

In contrast, BSAI 4 allowed fishing within 3 to 12 miles of the Aleutian Islands on the narrow margin of the Continental Shelf. The potential offsetting effects would be increased benthic damage around the Aleutian Islands and less damage in other areas. With BSAI 4, it is inferred that since more productive fishing grounds were being accessed, fewer trawls would be required to reach harvest quotas resulting in less overall trawl damage to the marine habitat. However, trawl damage tends to most severe in areas of highly localized fishing where the benthos is repeatedly disrupted. Decreased but more localized fishing effort might actually be more damaging. The net habitat effect resulting from BSAI 4 could not be determined.

Further discussion of the impact of past amendment and management actions on habitat is contained in Section 3.6.5.

Seabirds and Marine Mammals

Interactions of the groundfish fisheries with seabirds and marine mammals may involve direct injury or mortality of these animals, or may result from prey competition where the groundfish fisheries catch species that form the prey base for marine mammals or seabirds. Efforts have been made to minimize the interaction in both of these areas. BSAI 36 and GOA 39 banned a directed fishery on forage fish, which are preyed upon by seabirds, marine mammals, and commercially important groundfish species. Forage fish are the principal diet of more than two thirds of Alaskan seabirds.

Other efforts to avert prey competition with the Steller sea lion are amendments dispersing Steller sea lion prey species, pollock, Pacific cod and Atka mackerel, in space and time. These actions were precipitated by the rapid decline in the western stock of Steller sea lions. Although scientific evidence of the relationship between the groundfish fisheries and Steller sea lion decline is a matter of controversy, measures were put in place in various FMP amendments to disperse the fishery and to prevent disturbance of the animals at rookeries and haulouts.

For further discussion of the effect of FMP amendments on seabirds and marine mammals, refer to Section 3.7.1 for seabirds, and to individual marine mammals species subsections in Section 3.8, under the headings relating internal effects from the MSA groundfish fisheries).

Socioeconomic Factors

Section 3.9.1 contains a historical overview of the fisheries that includes a section on changes since the implementation of the FMPs. Impacts of the FMP amendments on harvesting and processing sectors are discussed in detail in Section 3.9.2.2.

Impacts of the CEQ program are discussed in detail in Section 3.9.4.3. Impacts of other amendments on communities are discussed in Section 3.9.3.

Ecosystem

Section 3.10.1.4 discusses the FMP management changes since the implementation of the FMPs in detail, and the impact of the amendments on the ecosystem.

3.2.4 Significant Changes to Bering Sea/Aleutian Islands and Gulf of Alaska Groundfish Fishery Management

Since the implementation of the BSAI and GOA FMPs in 1978 and 1981 respectively, the manner in which the groundfish fisheries have been managed as adapted and changed. These changes have been incrementally analyzed in terms of the specific actions implemented by the individual FMP amendments, and their impacts, as summarized above. When viewed cumulatively, however, it is apparent that the current fishery management philosophy is built upon the incremental responses of the last twenty years.

This section attempts to identify the significant changes to the way in which the groundfish fisheries are managed, since the implementation of the FMPs. The changes identified in this section have been deemed significant by NOAA Fisheries analysts, however due to the qualitative nature of this discussion, the list may not be exhaustive. Additionally, the discussion of the amendments is primarily based on the NEPA documents

that analyzed the action (Environmental Assessments [EAs] or EIS). While these documents do address the purpose and need for proposing a change to existing management conditions, and often include a rationale for selecting a preferred alternative, the full debate regarding the implementation of a particular amendment is not always apparent in the NEPA analysis, particularly if changes are made as a result of Secretarial disapproval. To the degree that the analysis below is based in large part on the analysis of the NEPA documentation, the discussion of significant changes may also be lacking.

The significant management changes since 1978 (GOA) and 1981 (BSAI) that have been identified by NOAA Fisheries analysts, are changes to the OF framework and to the apportionment of quota; methods to minimize bycatch particularly of prohibited species; tools to deal with excess capacity; means for protecting communities dependent on fishing; monitoring and reporting programs; and frameworking and flexible management.

The establishment of a multi-species groundfish OY range in the BSAI and GOA FMPs represented a significant shift in groundfish fishery management. Although the implementation of the BSAI OY range was Amendment 1 to the BSAI FMP, it was analyzed as part of the FMP EIS. The establishment of an OY range in the GOA was accomplished in GOA 15. This change allowed considerably more flexibility of management, as the annual quota for an individual species was no longer defined in the FMP and would be set annually, based on best available science and in accordance with the TAC frameworking procedures in the FMP, using the more streamlined regulatory amendment process. GOA 15 was implemented in 1987. In the eight years prior to its implementation, OY adjustments had been made in eight of the thirteen amendments.

The implementation of the OY range in the BSAI has also had other impacts due to the fact that the maximum limit of the FMP-defined OY range is constraining on the sum of groundfish acceptable biological catch (ABCs) in the BSAI. The sum of groundfish ABCs for 2003 was approximately 3.5 million mt, while the maximum limit of the OY range is set at 2 million mt. As a result, North Pacific Fishery Management Council (NPFMC) has a great deal of leeway in setting TACs in the BSAI, in determining which species should be fished to the level of their ABC and which should not. The cap on OY is believed by NPFMC to be an effective conservation measure that mitigates uncertainty, particularly in the BSAI, and the use of the existing OY ranges has been reaffirmed by NPFMC in the Preliminary Preferred Alternative.

Another significant change since the implementation of the FMPs is to the apportionment of annual quota. In the original FMPs, the domestic fishery received a species-specific catch quota for the managed groundfish species that, in the GOA, was spatially divided among five statistical areas. The foreign catch quota in the GOA was both spatially distributed and also had seasonal restrictions, and although not specified in the FMPs, the foreign catch quota was allocated among nations. Since the implementation of the original FMPs, the spatial, seasonal, directed fishery and gear-specific subdivision of species quota allocation has increasingly become a management tool that is used to address a variety of problems. In the GOA FMP, quota was divided among the statistical areas to “reduce the likelihood of uneven exploitation on localized stocks or concentrations,” (NMFS 1978). This issue was echoed in BSAI 28, where the ability to apportion the Atka mackerel TAC over subdivided AI districts allowed for a higher Atka mackerel ABC than would otherwise be recommended if the directed fishery were allowed to take the quota all from one spatially concentrated portion of the subarea (NMFS 1993). Seasonal quota allocations (BSAI 14 and GOA 19) and the creation of species-specific management districts (BSAI 17 and GOA 18) were also used as tools to protect the pollock stock against intensive fishing on spawning aggregations.

The subdivision of allocation by gear type has also been used to resolve socioeconomic issues such as gear conflicts and grounds preemption disputes. Further discussion may be found under "Socioeconomic Actions" in Section 3.2.3.1 above. Due to the difference in selectivity and bycatch rates among different gear types, excessive groundfish bycatch by a particular gear-type may result in a target fishery being closed before the quota is reached, when that quota could safely be harvested by vessels of a different gear type without triggering a bycatch concern. To the extent that species allocation by gear type allows the fishery to achieve the optimum harvest levels, and avoids gear conflict, it is a useful tool that will continue to be used by the NPFMC. The downside of subdividing allocations is that it requires increased attention from NOAA Fisheries managers, in terms of the potential need to close fisheries, reallocate incidental catch amounts, or investigate overages. In 2003, in BSAI, there were 152 non-CDQ TAC allocations, and 29 TAC allocations for each of the six CDQ groups. This represents a 23-fold increase from 1995.

The use of PSC limits has also been a significant change in fisheries management since the implementation of the original FMPs. Although prohibited species, that must be discarded at sea, were specified in the original FMPs, limits on their catch were not formally included in the FMPs. Subsequent amendments first specified catch limits on foreign catch of halibut in the GOA, and Chinook salmon, halibut and crab in the BSAI. Once its PSC limit was reached, the nation was prohibited from fishing in the management area or subarea. The application of PSC limits as a tool for reducing prohibited species bycatch was subsequently applied to the domestic fleet trawl sectors, and then to the fixed gear sectors, and apportioned by area or season. The NPFMC continues to find PSC limits to be an effective method for reducing bycatch, and the establishment of PSC limits for salmon, crab and herring in the GOA are included in the Preliminary Preferred Alternative (PPA). Analysis to address salmon bycatch, and suggested PSC limits for the GOA, have already been initiated.

PSC limits have been implemented in response to increased concern as to the rate of prohibited species bycatch in the groundfish fisheries. Prior to the full domestication of the groundfish fisheries, domestic catch of prohibited species was not a matter of concern. Once the issue was raised at the NPFMC level, however, PSC limits have been demonstrably effective in reducing PSC in the groundfish fisheries. For details on the specific reductions in prohibited species bycatch, see Appendix C BSAI Amendment description for BSAI 21b, 25, 35, 37, 40, and 41.

Since the domestication of the groundfish fisheries, excess capacity has increasingly become an issue for the NPFMC. Programs such as the vessel moratorium program, the license limitation program, the individual fishing quota program for sablefish, and the AFA cooperatives for BSAI pollock, have all changed the nature of groundfish fisheries from their state as described in the original FMPs. The impact of these programs is described in detail in Section 3.9 of this document. The NPFMC has identified comprehensive rationalization as a policy goal since 1992. In the PPA in this document, the NPFMC has reaffirmed its intention to further decrease excess capacity and overcapitalization through eliminating latent licenses and extending programs such as community or rights-based management to some or all groundfish fisheries.

The NPFMC has also specifically prioritized the implementation of management measures that provide stable economic opportunities for fishery-dependent coastal communities. This includes management measures that provide allocations to small vessels or particular gear types, such as allocations to jig gear (BSAI 24 and 34). Additionally, consideration for coastal communities is important during the development of area restrictions such as closure areas, that they still allow access for local vessels. The inshore-offshore issue in the pollock fleet also included coastal community consideration, as communities hosting a processor were more likely to benefit from inshore allocations (BSAI 18, 38, and 61 and GOA 23, 40, and 51). The establishment of the

CDQ program for western Alaska coastal communities is a well-developed illustration of community protection, where a percentage of the TAC for each BSAI groundfish and crab species is allocated among six CDQ groups. The economic impacts of the CDQ program are discussed in detail in Section 3.9.4.3. The NPFMC is currently developing a program in the GOA for eligible communities to purchase sablefish quota share (GOA 66). The shift in emphasis to provide for sustainable fisheries-dependent communities influences all groundfish fishery management actions, and in particular is a major criterion in the development of future rationalization programs.

The original FMPs established specific monitoring and reporting requirements for the foreign fisheries, and minimal reporting requirements for the domestic fisheries. As the domestic fleet began to increase their proportion of the North Pacific TAC, however, the need for more timely and comprehensive domestic fishery data became apparent. Section 3.2.3.1's "Management and Monitoring Actions" provides a summary of the various FMP amendments that increased observer coverage for domestic fishery operations and expanded recordkeeping and reporting requirements. On the one hand, these programs, in combination with NOAA Fisheries independent resource surveys, are part of one of the most comprehensive fishery data collection systems in the world (Appendix F-11). Acknowledged deficiencies of the system are the non-random observer coverage in the 60 ft to 125 ft sector of the groundfish fleet, and the lack of observer coverage on vessels smaller than 60 ft. Additionally, the economic data collected is mostly limited to price and revenue data. In order for fishery managers to assess the full economic impact of their decisions, it is necessary to expand the range of economic data collected to include, for example, expenditure, employment and earnings data. These deficiencies are addressed in policy objectives in the PPA.

Since the implementation of the FMPs, a major management emphasis has been on frameworking of management measures. The process for implementing FMP amendments is time-consuming, and does not allow for quick responsiveness to new conservation or management issues. In contrast, the nature of fisheries management is variable, with stock sizes fluctuating naturally from year to year. As a result, when rapid reaction to a conservation issue is required, the immediate management response must often by implemented by NOAA Fisheries' emergency rule, and after the fact be supported by an FMP amendment and requisite analyses. As a result of the bureaucracy of this latter procedure, the NPFMC has attempted to framework those management measures that are reviewed and adjusted on a regular basis, so that their change does not trigger the procedure of an FMP amendment. Instead, the procedure for regular review and modification is outlined in the FMP, along with the NPFMC intent and authorization, and as a result, the actions can subsequently implemented through regulatory amendments rather than FMP amendments. Various management measures have been frameworked in this manner, including the TAC-setting process as discussed above. Additionally, setting annual PSC limits for some prohibited species, setting season start dates, inseason management measures, and granting experimental fishing permits are all actions that are authorized in the FMPs, often with specific criteria and procedural requirements, but are implemented through regulatory amendments.

Another example of a frameworked procedure is the 'hot spot' authority granted to NOAA Fisheries. NPFMC has frequently attempted to amend the FMPs to allow the NOAA Fisheries Regional Administrator the field authority to implement temporary time or area closures to specific areas for conservation reasons (known as 'hot spot' authority), such as if a particular fishing ground seems to be producing high bycatch rates (BSAI 1, 4, 10, 16a, 19; GOA 15, 24). Although numerous efforts were made, between 1983 and 1992, to refine the authorization language, and enable temporary fishery closures by regulatory amendment, the original rapid reaction intent has not been met. The standards of evidence and public comment periods required in order for inseason management to close an area to fishing do not permit for flexible, temporary

closures of the type envisioned by the NPFMC. The principle of 'hot spot' closures has been used voluntarily in the BSAI pollock cooperatives, however, to reportedly good effect. A review of the effectiveness of bycatch reduction in the BSAI pollock fishery is currently initiated in the PPA.

This page intentionally left blank.

3.3 Physical Oceanography of the Fisheries Management Units

3.3.1 The Northeast Pacific Ocean

3.3.1.1 Description

Bounded on the north and east by the North America land mass, and essentially open to the west and south, the northeast "quadrant" of the Pacific Ocean includes the GOA and the Bering Sea (Figure 3.3-1). Although separated from the main ocean body by the Aleutian Islands, the Bering Sea is considered to be a northern "extension" of the northeast Pacific Ocean by virtue of hydraulic communication through the numerous passes and channels between the islands. On the west and south, the bounds of the northeast Pacific Ocean are generally considered to be, respectively, the International Dateline and the northern 30th parallel.

Although dotted by numerous seamounts rising to within 1,000 meters (m) of the surface, seabed depths over most of the northeast Pacific Ocean tend to be greater than 4,000 m. Maximum depths of more than 7,000 m occur in the Aleutian Trench, which parallels and marks the southern base of the Aleutian Island chain (Figure 3.3-1). Along the land boundary, the continental shelf (depth $\leq$ 200 m) is relatively narrow (< 50 kilometers [km]) along the British Columbia and Southeast Alaska coasts, and then broadens to 100 km or more along Southcentral Alaska coast. Along portions of the Kenai and Alaska Peninsulas the continental shelf attains a width of nearly 200 km.

3.3.1.2 Circulation

Surface currents in the Pacific Ocean are driven by the trade winds and westerlies, such that surface flows are predominantly westward in low latitudes (10° - 30°N) and eastward in high latitudes (35° - 50°N). When these flows encounter the continents they are diverted both north and south to form coastal currents, which further serve to establish rotating water masses ("gyres") that characterize the overall circulation patterns of the ocean (Figure 3.3-1).

The seaward "boundaries" of the northeast Pacific Ocean are arbitrarily, if not practically, determined by large-scale circulation features that result from these planetary driving forces. On the south, the North Pacific Drift transports surface waters eastward along (approximately) the 45th parallel. Upon reaching the North American continent, this flow splits into northbound and southbound branches known, respectively, as the Alaska Current and the California Current. As the Alaska Current tracks anti-clockwise along the continental margin, portions of it are known as the Alaska Coastal Current and the Alaskan Stream, as will be explained in subsequent sections. The anti-clockwise "loop" is closed by the Aleutian Current, which is a south-to-southeasterly extension of the Alaska Current (Figure 3.3-1). The resulting anti-clockwise circulation pattern is known as the Alaskan Gyre.

Winter intensification of the Aleutian Low leads to strong southeasterly winds along the Southeast Alaska coast, which produce onshore Ekman transport and downwelling of coastal waters (Royer 1975). During summer, the North Pacific High tends to dominate the region such that lighter, more variable winds result in a relaxation of the coastal convergence, but the overall anti-clockwise circulation is maintained by the introduction of fresh water along the coastline, as described in the following section.

3.3.1.3 Water Mass Characteristics

In the North Pacific high latitudes, surface waters have relatively low salinities because of the excess of precipitation and runoff over evaporation. Cooling these surface waters even to the freezing point does not make them sufficiently dense to cause them to descend any deeper than 200 m in the water column. Consequently, the deeper water in the North Pacific must originate elsewhere and, necessarily, must flow in through the South Pacific because the connection with the Arctic Ocean, through the Bering Strait, is too narrow and shallow to be of consequence.

These deeper waters of the North Pacific originate in the Southern (i.e. Antarctic) and North Atlantic Oceans, where the combination of surface temperatures and salinities produces very dense waters that subsequently sink to the sea floor. The Pacific Ocean has been described as a vast estuary, with low-salinity surface outflow from the North Pacific mixing with deeper, more saline water flowing in at depth through the South Pacific. Ultimately, the increasingly dense North Pacific water returns to the areas of sinking in the North Atlantic to complete the circuit, which is estimated to take centuries to complete.

Nutrients are distributed throughout the world's oceans by this system of deep circulation. For example, inorganic phosphates are consumed by plant growth at the surface and are regenerated at greater depths as the plants die, sink, and decay. Consequently, nutrients are in greater concentrations at depths of 1 to 2 km than at the surface. Inflow of the deeper water into the Pacific brings in water that is high in phosphate compared to the average concentration in the Atlantic. As a result, the accumulated phosphate in the Pacific Ocean has a concentration about twice that of the Atlantic.

The next two subsections describe in greater detail the physical oceanography of the two federal fisheries management units (FMUs) of the northeast Pacific Ocean. A final subsection addresses the sources and magnitude of variability in oceanic parameters.

3.3.2 Gulf of Alaska Fishery Management Unit

3.3.2.1 Description

The GOA FMU includes all waters within the EEZ along the southeastern, southcentral, and southwestern coasts of Alaska from Dixon Entrance to Unimak Pass, a distance along the Alaskan coastline of more than 2,500 km (Figure 3.3-1). Greatest depths within the GOA FMU range from 3,000 m off Southeast Alaska, to 4,000 m off southcentral, and to 7,000 m at the west end of the FMU, where the Aleutian Trench begins. However, the continental shelf areas (depths < 200 m) are of greatest importance in the context of fishery management issues.

As noted previously, the continental shelf within the GOA FMU is narrowest in Southeast Alaska, ranging in width from less than 50 km between Dixon Entrance and Cape Spencer, and then broadening to 100 km or more along the southcentral coast to Seward. South of the Kenai Peninsula and west of Kodiak Island, the continental shelf is broadest, about 200 km, on Portlock Bank. Proceeding westward from Kodiak along the Alaska Peninsula, the shelf narrows gradually from 150 km to about 50 km at Unimak Pass. The progressive broadening and narrowing of the continental shelf from east to west plays an important role in the circulation of waters through the GOA FMU.

3.3.2.2 Circulation

Water movements within the GOA FMU are dominated by the Alaska Coastal Current (ACC) which changes character and direction three times and is joined by other narrower currents as it is forced by the coastline to change direction from northwestward to westward to southwestward as it flows through the unit (Figure 3.3-1). Starting off Southeast Alaska like a wide river with imbedded eddies the main flow turns westward with the coastline and becomes two currents as it is joined by the faster ACC close to shore. As the coastline turns southwestward the flow seaward of the shelf break accelerates taking on the dynamics of a western boundary current, the Alaskan Stream, which reaches speeds of 60 to 100 centimeters per second (cm/sec) staying in a narrow jet over the continental slope to the end of the unit. This broad southwestward flow is now in four bands; the weak offshore portion, the swift Alaskan Stream, a weak tidally and bathymetry influenced flow on the outer shelf, and the moderate ACC inshore. Some of the offshore flow recirculates to the south then east forming the western branch of the GOA Gyre. This coastal circulation is driven in winter by the persistent anti-clockwise wind stress over the GOA and in summer by the immense fresh water input from coastal sources in British Columbia and Southeast Alaska.

During the winter, when coastal runoff is minimal, anti-clockwise atmospheric circulation is most intense over the GOA, and wind stress maintains the coastal circulation with strong onshore convergence or downwelling. During summer, when winds over the GOA slacken considerably, coastal runoff increases dramatically and creates a density gradient in nearshore waters that serves to maintain the anti-clockwise coastal circulation. Thus seasonal variations in wind stress and coastal runoff are balanced so that, together, they serve to maintain the generally steady westward movement of water through the GOA FMU.

Circulation near the continental shelf break (~ 200 m depth) generally follows the isobaths, with frequent eddies and meanders. Closer to shore the flow is more stable, with fewer eddies, and is more closely aligned with the coastline. Within the broader Alaska Current, a narrow and intense coastal current called the ACC extends from Southeast Alaska to Kodiak Island. The ACC results from the density gradient produced by prodigious amounts of freshwater runoff that varies with the annual hydrologic cycle (Royer 1979, 1983). The width of the ACC varies from only 5 to 10 km wide to as much as 40 to 50 km, depending on the rate of freshwater input. Current speeds within the ACC occasionally exceed 100 cm/sec, which has caused occasional reference to it as a "coastal jet." The dilutional effects of the freshwater input are generally confined to the top layers (50 to 100 m) of the water column. The western segment of the ACC has been called the Kenai Current (Schumacher 1980).

West of Kodiak Island, where freshwater input is much reduced, the Alaska Current is driven more by prevailing winds. Accordingly, in winter a westward flow is maintained by wind stress, but in summer this driving force is somewhat lessened so current reversals and eddies occasionally occur (Schumacher and Reed 1986).

3.3.2.3 Water Column

The density structure of the water column is determined by its physical properties, most notably its temperature and salinity, as they vary with depth. At the temperatures typical of the northern GOA water (i.e. < 10 degrees Celsius [° C]), salinity is the dominant determinant of water density. Because of the plentiful coastal runoff and the excess of precipitation over evaporation, coastal waters of the GOA have salinities that are significantly lower than those of the North Pacific, which are already low relative to the world's oceans. Salinities at depths less than about 10 m in the GOA FMU are typically 25 to 30 practical salinity units (psu).

Salinity and density increase with depth, but the greatest rate of increase occurs within the pycnocline, which extends from about 30 m to 200 m depth. Above the pycnocline is the "surface mixed-layer," in which the salinity is 32 to 33 psu. Below the pycnocline, salinity increases slowly to about 34.4 psu at a depth of 1,500 m. Temperatures in the mixed layer vary from 3° to 12° C seasonally. Below the pycnocline the temperature decreases slowly from 3° to 2.5° C near 1,500 m. These are relatively permanent features so significant changes occur only rarely, and then only as a result of large-scale changes in circulation. Ranges of physical properties of GOA waters are listed in Table 3.3-1.

Small horizontal changes in water properties occur as the flow proceeds westward, but mainly in the mixed layer. Nearshore salinities in the eastern and northern GOA can be as low as 26.0 psu in the ACC in the fall when precipitation is at its maximum. Along the edge of the shelf in the Alaskan Stream a low-salinity (<32.0 psu) tongue like feature protrudes westward. In Shelikof Strait and to the east, the range of temperatures (0° to 15° C) can be substantially greater than those farther west. Whereas surface salinity increases toward the west as sources of fresh water from the land diminish, salinity values at 1,500 m decrease very slightly. Temperatures at all depths tend to decrease toward the west.

Some chemical properties of GOA water make it unique in the world ocean. Compared to other ocean waters at similar latitudes, the deep water of the GOA has higher concentrations of silicate, phosphate, and nitrate and its well-developed oxygen minimum. The oxygen and phosphate distributions result from the decomposition of particulate organic matter sinking from the surface, as elsewhere, but the higher concentrations arise because of accumulation resulting from poor circulation of the deep water. Reeburgh and Kipphut (1986) examined GOA chemical profiles for dissolved oxygen, silicate, phosphate, and nitrate, and summarized available historical data in three distinct oceanographic domains: 1) the deep sea, 2) the continental shelf, and 3) fjords and estuaries. Of the three, the shelf domain has the least data.

Deep sea profiles show temperature decreasing continuously with depth, first in the main thermocline from 10° C at the surface to 6° C at 100 m, then gradually to 4° C at 350 m and even more slowly to 1.8° C at 2,500 m (Reeburgh and Kipphut 1986). Dissolved oxygen decreases from about 300 micro meters (µM) O_2/kilogram (kg) at the surface to less than 50 µM O_2/kg at 400 m, followed by a minimum near 900 m then a gradual rise to about 120 µM O_2/kg at 4,000 m. Phosphate increases from 0.5 µM H_3PO_4-P/kg at the surface to a maximum of almost 3 µM H_3PO_4-P/kg from 500 to 1,500 m, then decreasing slightly to about 2.6 µM H_3PO_4-P/kg near 2,500 m. Nitrate increases from about 0.3 µM NO_3-N/kg at the surface to a maximum of about 40 µM NO_3-N/kg from 500 to 1,500 m, then decreases only slightly to about 35 µM NO_3-N/kg near 2,500 m. Silicate increases from about 5 µM $Si(OH)_4$-Si/kg to 150 µM $Si(OH)_4$-Si/kg at 500 m, then continues to increase slightly to 175 µM $Si(OH)_4$-Si/kg at 2,500 m. The dissolved oxygen minimum and the phosphate and nitrate maxima occupy similar depth zones. Some studies have investigated long-term variability in the deep sea using Ocean Station P data. Surface nitrate was never less than 10 µM, even during peak uptake. Hokkaido University (1981) confirmed measurable nitrate was always present and probably does not limit surface productivity. A well-established population of pelagic grazers appears to be responsible for the relatively high surface-nutrient concentrations (Miller *et al.* 1984).

The nutrients in the shelf waters interact horizontally and thus have similar properties to the shallow (< 250 m) range of the oceanic water described above. Seasonal changes depend upon the seasonal variations in the meteorological regime (Royer 1975). In the winter, southeasterly winds bring convergence and downwelling (Royer 1981) along with the winter cooling and replacement of warm, high-saline bottom waters. In the summer, the wind field reverses, bringing relatively warm, high-saline, low-oxygen high-nutrient waters from the central GOA back onto the shelf at depths of 100 to 200 m. Nitrate profiles from near the mouth of

Resurrection Bay show values 20 - 40 µM between 0 and 250 m depth during winter, and summer values of 1 to 30 µM over the same depth range.

Few nutrient studies have been done in fjords and estuaries, but exchange with the shelf water has been determined from a few localized intensive studies to be a function of sill depth. No anoxic conditions were observed in Alaskan fjords, indicating at least annual bottom water renewal (Muench and Heggie 1978). Shallow-silled (< 50 m) fjords renewed between February and April when surface waters were most dense. Intermediate sill depth (120 to 160 m) fjords followed shelf water density changes and led to fairly continuous flushing. Deep or unrestricted sill (> 180 m) fjords are flushed between July and October, when warm, saline, higher-nutrient water returns to the shelf after the relaxation of convergence.

3.3.3 Bering Sea/Aleutian Island Fishery Management Unit

3.3.3.1 Description

The Bering Sea is a semi-enclosed, high-latitude, subarctic sea, and is considered to be a northern extension of the North Pacific Ocean. Shaped somewhat like a sector of a circle with its apex at the Bering Strait, the Bering Sea has a total area of 2.3 million square kilometers (km^2), of which 44 percent is continental shelf (depth < 200 m), 13 percent is continental slope, and 43 percent is deepwater basin, where depths reach as much as 3800 m along the western margin of the sea. The broad continental shelf on the east side of the Bering Sea is one of the most biologically productive areas of the world. The BSAI FMU comprises most of that continental shelf and consists of the entire eastern Bering Sea (EBS) from the Alaskan coastline westward to the international boundary. Also, those waters within the EEZ south of the Aleutian Islands from Unimak Pass to the international boundary are included in the BSAI FMU (Figure 3.3-2).

3.3.3.2 Circulation

Numerous straits and passes through the 2,000-km arc-shaped Aleutian and Komandorski archipelago connect the Bering Sea to the North Pacific Ocean. The amount of water exchanged between the North Pacific Ocean and the Bering Sea through passes between the various Aleutian Islands is uncertain. Waters from the Alaska Current enter the Bering Sea at Unimak Pass and, to a lesser extent, through other passes between Aleutian Islands. Major exchanges of water occur at the west end of the Aleutian-Komandorski archipelago, with large inflow to the Bering Sea through Near Strait and outflow through Kamchatka Strait. Some additional "leakage" into the Bering Sea occurs through passes between the islands just east of Near Strait.

As the warm Alaska Stream water enters the Bering Sea and is cooled and transported through the anti-clockwise Bering Sea Gyre, large upwellings occur, bringing cold deep waters to the surface (Ohtani 1970). Eddies, ranging in diameter from 10 to 200 km, can be found throughout the Bering Sea, and contribute to the vertical mixing of waters. These eddies are thought to be caused by instabilities, wind forcing, strong flow through passes in the U.S., and topography (Schumacher and Stabeno 1998).

To the north the Bering Sea is connected with the Chukchi Sea and Arctic Ocean through the Bering Strait, which separates the Seward Peninsula (Alaska) from the Chukotka Peninsula (Russia). At the Bering Strait, there is a relatively small net annual outflow of water (Coachman and Aagaard 1988), although this flow can be reversed by relatively rare combinations of meteorological conditions (Coachman and Aagaard 1981).

Patterns of circulation in the Bering Sea have been inferred mostly from distributions of water properties, but some knowledge has also been obtained from drifter studies (Stabeno and Reed 1994). The overall circulation pattern is generally anti-clockwise within the basin, with the most prominent feature on the east side being a weak and variable northwestward flow over the broad continental shelf adjacent to Alaska. Along the edge of this shelf the Bering Slope Current transports water northwest at speeds of 10 to 20 cm/sec (Kinder *et al.* 1975, 1986), although Royer and Emery (1984) believe this flow to be somewhat slower in winter. The Bering Slope Current intensifies as it approaches the Asian continent, bifurcating into a northerly flow through the Gulf of Anadyr and a southwesterly flow that is the origin of the Kamchatka Current, an intense western boundary current that continues southwestward along the Russian coast (Figure 3.3-2).

Flow over the North Aleutian Shelf (adjacent to Alaska) is characterized by Schumacher and Reed (1992) as weak and variable, with low current speeds (< 5 cm/sec). Mean speeds observed in the central shelf area are less than 1.0 cm/sec, and reveal no organized circulation (Kinder and Schumacher 1981). Within Bristol Bay the *mean* flow is weak and shows an anti-clockwise tendency along the perimeter of the bay. Maximum speeds (~ 3.5 cm/sec) occur near the 50-m isobath and near the coast. However, the vast majority of the velocity variance within the bay is tidal, with tidal currents an order of magnitude larger than the mean flow. For example, on the north Aleutian shelf, where net currents are only 1-5 cm/sec and the typical wind-driven currents are approximately 10 cm/sec at 5-m depth, the tidal currents are 40-80 cm/sec or more (Thorsteinson 1984). Turbulence resulting from these tidal currents causes mixing of the water column from the seabed to about 50 m above it.

3.3.3.3 Hydrography

Hydrographic structure over the U.S. is well-defined and consists of three domains that are separated by physical fronts (Kinder and Coachman 1978, Schumacher *et al.* 1979, Kinder and Schumacher 1981). The inner front is aligned approximately with the 50-m isobath, the middle with the 100-m isobath, and the outer at the shelf break (~ 200 m). The associated oceanographic "domains" are referred to as the coastal domain, middle domain, and outer domain. Two other distinct domains exist off the shelf: a narrow, energetic shelf break domain and the deep-ocean domain. The Pribilof Islands and the Unimak Islands also provide distinct separate habitats within the Bering Sea. These domains will be referred to repeatedly in the following sections that describe the characteristics of the Bering Sea.

Circulation over the shelf is related to domain structure (Coachman 1986). In the outer domain (100 to 200 m), tidal currents account for about 80 percent of the flow, with a mean of about 5 cm/sec along shore to the northwest and an onshore-offshore flow of 1 to 5 cm/sec that is quite variable. Tidal mixing is very important in the outer domain. In the middle domain (50 to 100 m) the only important flow is that due to tides and inertial currents. There is very little net motion, and vertical mixing due to tides is also important here. Tidal currents account for about 95 percent of the flow energy in the coastal domain (< 50 m), but as already noted, the mean flow has a speed of only 1 to 5 cm/sec in a generally northwest direction. In contrast to circulation of the GOA, the circulation of the Bering Sea shelf has relatively small net flows and relatively large tidal forcing.

There are two main water masses on the shelf: Alaska Coastal water and central Bering water. Coastal water is found shoreward of the 50-m isobath in the south U.S., while central Bering water is found in the middle domain, from the inner front (~ 50 m) to the middle front (~ 100 m). Alaska Coastal water is a combination of coastal freshwater discharge and more saline water from the deep basin, and is generally well-mixed by winds and tides. The central Bering water in the middle domain has a lower layer that is isolated from

seasonal heating and thus has temperatures that reflect prior winter conditions. Water of the outer domain (100 to 200 m) is not really an identifiable water mass, but instead is a mixture of central shelf and deep Bering Sea water. Because of greater tidal and advective energy, it is less strongly stratified than the middle domain but exhibits considerable small-scale vertical variation in properties that originate in the middle domain. These vertical variations, known as vertical "fine structure," are important to the flux of water properties horizontally and vertically through the water column.

Hattori and Goering (1986) summarized the available data on the distribution of salinity, temperature, phosphate-phosphorous, nitrate-nitrogen and ammonia-nitrogen, and slicic acid (Table 3.3-2) and characterized the four domains according to nutrients. Because the fronts inhibit lateral fluxes of water and dissolved materials between the four domains, nutrient zones are consistent with the physical domains. The vertical physical system also regulates the biological processes that lead to separate cycles of nutrient regeneration. The source of nutrients for the outer domain is the deep oceanic water and for the middle domain, it is the shelf-bottom water. Starting in winter, surface waters across the shelf are high in nutrients.

Spring surface heating stabilizes the water column, then the spring bloom commences and consumes the nutrients. Steep seasonal thermoclines over the deep Bering Sea at depth of 30 to 50 m, the outer domain at 20 to 50 m, and the middle domain at 10 to 50 m restrict vertical mixing of water between the upper and lower layers. Below these seasonal thermoclines nutrient concentrations in the outer domain are invariably higher than those in the deep Bering Sea water with the same salinity. Winter values for nitrate-N/phosphate-P ratios are similar to the summer ratios which suggests that, even in winter, the mixing of water between the middle and outer domains is substantially restricted (Hattori and Goering 1986).

Spring and summer storms can increase the total seasonal productivity by mixing to depths sufficient to resupply nutrients to the euphotic zone, but by the end of summer, nutrient depletion in the euphotic zone is common all across the shelf. Year-to-year consistency of trends between summer nutrient distributions in 1975 and 1978 was shown by Hattori (1979).

3.3.3.4 Effects of Sea Ice

Oceanic conditions, both physical and biological, can be profoundly influenced by the presence of sea ice. During extreme winter conditions, sea ice covers the entire eastern shelf of the Bering Sea; however, interannual variability of coverage can be as great as 40 percent (Niebauer 1988). The growth of ice over deep water is limited by relatively warm water in the central basin, so the maximum extent of the ice is restricted to the shelf.

The ice generally begins its seasonal southward formation in November. It is estimated that about 97 percent of the ice in the Bering Sea is formed within the Bering Sea itself (Leonov 1960). Very little ice is transported south through the Bering Strait (Tabata 1974). The ice apparently forms like a giant conveyor belt, being generated along the south-facing coasts in the Bering Sea and moving southward at as much as 0.5 meters per second before finally melting at its southern limit (Pease 1981). On average, seasonal ice formation progresses at an average rate of 12 to 13 percent per month over the area of the eastern shelf, reaching 60-65 percent coverage by late March (Niebauer 1981). The ice advance generally consists of a short, rapid advance (~ 24 percent per month) in November-December, before slowing to ~6 to 7 percent in December-March. With the exception of the rapid advance in November and part of December, the ice appears to dissipate faster than it forms, at about 18-20 percent per month in late March to early July.

Lisitsyn (1960) reported that, during the period of ice retreat, 63 percent of the ice melts within the Bering Sea basin. The remainder leaves the Bering Sea by way of various straits and passes.

The sea ice affects exchanges with the atmosphere and inhibits the transfer of freshwater (salt) and heat. It changes the coupling of the oceanic and atmospheric momentum exchanges by altering the surface roughness. The creation and melting of the sea ice alters the horizontal and vertical density gradients in the water column. Increases or decreases in the vertical density gradient affect the mixing and transport of nutrients and organisms in the euphotic zone. The ice edge also serves as both source and sink of freshwater that can affect productivity. In fall during freeze-up, freshwater is extracted from the seawater, while during the spring, melting supplies freshwater to the ice edge.

One might reasonably assume that primary productivity in a winter ocean covered to a large extent by ice would be low and uncomplicated. However, McRoy and Goering (1974) reported on studies that revealed a complex productivity system in the water column and ice that makes a measurable contribution to the total annual production of the Bering Sea. The annual increase in production in the Bering Sea begins in late February with the development of the algal community in the sea ice. The production of this community increases with the passing of winter and probably reaches a maximum just before the ice melts completely. The ice algae comprise the first spring bloom that occurs in the Bering Sea, preceding the bloom that occurs in the open water farther south.

In April, as the ice melts, a second spring bloom develops in the wake of the receding ice. This begins along the southern ice front, coinciding approximately with the edge of the continental shelf. This bloom is promoted by the stability associated with the low-density water around the melting ice. As a result of the seasonal ice cover, the annual primary production of the Bering Sea is actually increased. Furthermore, the annual spring increase in algal standing stock begins in the middle and northern Bering Sea rather than the expected southern waters. Niebauer *et al.* (1990) subsequently estimated that the ice edge bloom of phytoplankton accounts for between 10 percent and 65 percent of the total annual primary production.

Sea ice also influences bottom temperatures, and hence influences many species on the shelf. In winter, there is little stratification, and the sea is cold from top to bottom. In colder years there is more sea ice than in warmer years. The ice helps to cause and maintain density stratification when it melts. After the ice has melted, solar heating causes further stratification, and thus bottom temperature changes only very slowly. Consequently, in cold years—years with extensive sea ice—the colder-than-normal bottom temperature is even more persistent than usual (Coachman 1986). Thus, the distribution and abundance of temperature-sensitive bottom-dwelling species and some nearshore species are related to the extent of sea ice. Variability (1972-1998) of sea ice arriving and departing the southern middle shelf is discussed by Stabeno *et al.* (2001).

3.3.4 Sources and Magnitude of Oceanic Variability

3.3.4.1 Atmosphere-Ocean Time Scales and Forcing Mechanisms

Atmospheric and oceanic parameters in the North Pacific and Bering Sea have variability that exists on several time scales and is due to many different forcing mechanisms (Table 3.3-3). Short-term (daily to annual) fluctuations in atmospheric and oceanic conditions are familiar and generally well-understood, to the extent that cause-and-effect relationships are well established. Fluctuations having longer (interannual) time scales are becoming better documented, thanks to extensive environmental monitoring activities, but definition of causal relationships for most remains an elusive challenge. The focus of this section is on

atmosphere-ocean interactions that occur on time scales of several months to several years, or even decades. No attempt is made to catalogue all possible sources of variability. Rather, only the few that are well-known are identified and their possible influences are described.

3.3.4.2 Mesoscale Eddies

Eddies are rotating masses of water that are formed when an ocean current is deflected or "pinched off" by a topographic feature on the seabed or at the continental margin. Eddies can also form as a result of velocity shear on the fluid boundary between a relatively swift current and a much slower moving water mass. Rotating around generally vertical axes, "mesoscale" eddies have diameters of tens to hundreds of kilometers and, depending on their size, have rotational periods measured in days, or even weeks. Because they dissipate their energy only very slowly, these eddies can have "lives" measured in months to years, and their trajectories can be traced by the persistence of water properties in their cores. Movement of an eddy past a fixed current meter is evidenced by a cycle of flow acceleration, deceleration, and then acceleration back to the mean flow speed (or vice versa).

Mesoscale eddies are ubiquitous features of oceanic circulation and occur frequently on continental shelves and slopes. Kinder and Coachman (1977) described observations of an isolated eddy of high-salinity water nestled in the outer reaches of the Pribilof Canyon and partially in water depths greater than 1,000 m. The temperature-salinity characteristics of the eddy were those of the Bering Slope Current. The authors attribute its formation as evolving from a pinching off of a meander of this current in a manner similar to that which occurs when the Gulf Stream (Atlantic Ocean) forms warm eddies that travel northward along the U.S. east coast. Similar eddy events have been observed in the northern GOA and reported by Royer *et al.* (1979). They describe a persistent clockwise 100-km feature lying off the continental shelf and attribute its formation to instabilities of the Alaska Current.

The role of mesoscale eddies in the ocean and, more specifically, in the GOA and Bering Sea, is not determined. However, eddies could play an important role in controlling exchange of water between the North Pacific and Bering Sea (Okkonen 1993). Eddies have an important role in mixing water masses, so they might be providing microclimates that enhance (or deter) productivity. And, of course, the interaction of eddies with other longer-term oceanic processes can serve to confound further comprehension of the overall circulation and its ecosystem-level effects. Accordingly, mesoscale eddies are essentially "noise" that is superimposed over the combined signal of longer-term quasi-periodic processes that are evident in the overall picture of oceanic variability.

3.3.4.3 Interannual Variability

The phenomenon known as El Niño – Southern Oscillation (ENSO) and described by Philander (1990), has long been recognized as a significant factor in the interannual variability of atmospheric-oceanic response. ENSO events radiate from the equatorial regions at irregular intervals, but ranging most commonly from three to seven years between events. ENSO events account for approximately one-third of the ice and sea surface temperature variability in the Bering Sea (Niebauer and Day 1989). ENSO forcing in the oceans at high latitudes is primarily through poleward propagation of Kelvin waves (Jacobs *et al.* 1994). This conclusion is supported by data of Enfield and Allen (1980), who found poleward-propagating, coastal-trapped disturbances along the west coast of North America that were correlated with equatorial disturbances. Royer (1994) reported that ocean temperature fluctuations at depth at GAK 1 (an oceanographic observation station near Seward) are well-correlated with ENSO events.

In addition to fluctuations associated with ENSO forcing, the water temperature variations at GAK 1 have been found to be associated also with the lunar nodal tide component, which has a period of 18.6 years (Royer 1994). This tide component is the twelfth largest of all tidal components and is related to the 18.6-year periodicity of the lunar declination. Equilibrium tide theory predicts that this tidal component will vary with latitude, with amplitudes increasing with latitude (Parker *et al.* 1995). Because the interdecadal sea surface variability seems to occur simultaneously in the GOA and Bering Sea, it is expected that this component forces Bering Sea parameters in a similar fashion as in the GOA. Temperature anomaly patterns are similar with no phase shift, which suggests that the forcing is simultaneous.

3.3.4.4 Interdecadal Variability

A chronology of interdecadal climatic changes affecting the North Pacific Ocean was compiled from available measured atmospheric pressure data by Minobe (1997) for the period 1899-1997. A climatic regime shift was defined as a transition from one climatic state to another within a period substantially shorter than the lengths of the individual epochs of each of the (two) climatic states. Data used included the North Pacific index (NPI), the area- and time-averaged sea level pressure anomalies in the region of 160°E to 140°W by 30° to 60°N for winter to spring (December to May), which illustrated rapid strength changes in the Aleutian low in the winter and spring seasons. Bidecadal pressure averages during 1899-1924 showed that the Aleutian low was about 1 millibar (mb) weaker than average, then strengthened to 1 mb below normal during 1925-1947. Similar behavior occurred in the later part of the Twentieth century as the Aleutian low shifted back to 1 mb above normal from 1948 to 1976, then strengthened back to 1 mb below normal during 1977-1997.

Using late-nineteenth century data for spring air temperature in western North America, Minobe (1997) identified 1890 to be the first regime shift. This extended the length of the first period to 34 years in comparison to the 22-, 26-, and 20+-year regimes to follow. The 50- to 70-year interdecadal variability (a two-regime cycle) has been prevalent from the nineteenth century to the present in North America. Minobe (1997) speculated that the likely cause of this variability is an internal oscillation in the coupled atmosphere-ocean system. This suggests that the next climatic regime shift is likely to occur between 2000 and 2007.

Long-term changes in fish populations around the North Pacific Ocean have apparently been influenced by climatic change of the same 50- to 70-year variability. Alaska salmon decreased in the 1940s and increased in the 1970s. Larger Japanese sardine catch amounts occurred in the regimes with the deepened Aleutian low. Baumgartner *et al.* (1992) found evidence of an approximately 60-year variability in sardine and northern anchovy populations in the eastern North Pacific from sediments in the Santa Barbara basin dating back to A.D. 270.

3.3.4.5 Regime Shifts

An update of evidence for regime shifts in the North Pacific Ocean in the 1920s, the 1940s, a major one in the winter of 1976/1977, and a minor one in 1988/1989 was presented recently at the North Pacific Marine Science Organization (PICES) symposium (Hare et al, Hare and Mantua, McFarlane *et al.*, Zhang *et al.*, Park and Oh, Kang *et al.*, Suga *et al.*, Yasuda *et al.*, Savelieva *et al.*, Rogachev, Overland *et al.*, Miller and Schneider, and Minobe, 2000). Coincidently, the beginnings of another large change in 1998/1999 were mentioned at the symposium; these are discussed in more recent papers by Minobe (2002), Conners *et al.* (2002), Mantua and Hare (2002), and Schwing *et al.* (2002).

In the late 1970s a step change in climate, referred to as a "regime shift," occurred in the North Pacific Ocean. While there is evidence to suggest that there have been previous regime shifts, as noted in the previous section, it was the 1970s regime shift that stimulated extensive research on the topic and, especially, how oceanic ecosystems were responding to these phenomena. Although more than a decade was required to recognize the pattern, the regime shift of 1976/1977 is now widely acknowledged, as well as its associated far-reaching consequences for the large marine ecosystems of the North Pacific Ocean. The 1989 regime shift has been studied extensively by Hare and Mantua (2000), who assembled and examined 100 environmental time series of indices (31 climatic and 69 biological) to obtain evidence of regime shift signals. A few examples of these illustrate that such signals are evident in the BSAI and GOA data.

Sea surface temperature anomalies (relative to long-term averages) around the Pribilof Islands indicate that the BSAI environmental regime appears to have shifted. The dominance of positive anomalies (warmer than average) from 1977 to 1988 switched abruptly to negative anomalies (colder than average) in 1989, which prevailed at least through 1997. Further evidence of a regime shift is seen in the time series of the southern extent of sea ice in the Bering Sea.

Niebauer (1998) reports that, prior to the late 1970s regime shift, below-normal sea ice cover in the Bering Sea was typically associated with El Niño conditions, which caused the Aleutian Low (atmospheric pressure center) to move east of its average, or "normal," position with the result that warm Pacific air was directed over the Bering Sea. Conversely, above-normal sea ice cover was associated with La Niña conditions, during which the Aleutian Low moves west of its normal position, allowing higher pressure and colder weather in the Bering Sea. However, since the1970s regime shift, El Niño conditions are causing the Aleutian Low to move even farther east, causing winds to blow from the east and north off Alaska and resulting in above-normal ice cover in the Bering Sea.

Before the regime shift, El Niño and La Niña conditions occurred with about the same frequency. Since the regime shift, El Niño conditions are about three times more prevalent. Both Mantua *et al.* (1997) and Minobe (1997) present evidence that this regime shift is the latest in a series of climate shifts that date back at least to the late 1800s and might be attributable to a 50- to 70-year oscillation in a North Pacific atmospheric-ocean coupled system.

Abundant evidence suggests that the coupled atmospheric-oceanic system of the North Pacific is subject to multiple forcing factors, each having characteristic behaviors and different frequencies of occurrence. The evidence also indicates that, rather than there being a single average or "normal" condition, the overall system appears to stabilize periodically around two or more "normal" states, changing from one to another abruptly in what has been termed a "regime shift." These are the characteristics of systems whose dynamics are addressed by "chaos" theory, which is a body of mathematical theory that focuses on systems that have multiple states of equilibrium. Chaos theory attempts to define the mechanisms that cause the systems to change from one equilibrium state to another and to predict all such equilibrium conditions.

Using available sea level pressure and sea surface temperature data, along with coastal air temperature data from Sitka, Overland *et al.* (2000) formulated a conceptual chaotic model for the North Pacific. They were able to determine that the energy content of North Pacific time series of these parameters is broad-banded (i.e. over a broad frequency range) and temporally irregular (i.e. non-steady with respect to time). They reported that their conceptual model reflects the observed irregular behavior and suggests that the transitions from one equilibrium state to another are rapid rather than gradual.

Use of the word "chaos" in this context is not to imply the more common definition of great confusion or disorder. Rather, its use invokes the mathematical implication that there is order behind the irregularity of the system. A chaotic model may lead to a better understanding of the low-frequency relationship between the physical and biological systems in the North Pacific. One characteristic of a chaotic system is that , near the time of major interdecadal transition, there could be several years of extreme, and perhaps opposite, anomalies in the physical system. These extremes provide opportunities for change in the biological system. Recent experience with North Pacific fisheries may provide examples of such transition periods.

Although the Bering Sea is not discussed, a new review paper summarizes many details and the big picture of multidecadal (about 50 years) change in the Pacific Ocean (Chavez *et al.*, 2003) characterized by about 25 year boom and 25 year bust cycles in the opposing anchovy-sardine populations. In the mid-1970s the change was from a cool anchovy regime to the warm sardine regime. Satellites have recently confirmed an increase in basin-wide sea-level slope after the 1997/1998 El Niño coincident with a dramatic increase in chlorophyl off California indicating a shift back to a cool anchovy regime that occurred in the middle to late 1990s. The effects of El Niño in the tropics which radiate north on a shorter cycle of 3 to 7 years and some unmeasured anthropogenic effects may tend to mask some of the synchronicity of changes in the physical and biological systems.

3.4 Threatened and Endangered Species

The ESA of 1973 as amended (16 United States Code [USC] 1531 et seq.), provides for the conservation of endangered and threatened species of fish, wildlife, and plants. The program is administered jointly by the NOAA Fisheries for most marine mammal species, marine and anadromous fish species, and marine plants species and by the USFWS for bird species, and terrestrial and freshwater wildlife and plant species.

The designation of an ESA listed species is based on the biological health of that species. The status determination is either threatened or endangered. Threatened species are those likely to become endangered in the foreseeable future (16 USC 1532(20)). Endangered species are those in danger of becoming extinct throughout all or a significant portion of their range (16 USC 1532(20)). Species can be listed as endangered without first being listed as threatened. The Secretary of Commerce, acting through NOAA Fisheries, is authorized to list marine and anadromous fish species, plants, and mammals (except for walrus and sea otter). The Secretary of the Interior, acting through the USFWS, is authorized to list walrus and sea otter, seabirds, terrestrial plants and wildlife, and freshwater fishes and plants.

In addition to listing species under the ESA, the critical habitat of a newly listed species must be designated concurrent with its listing to the "maximum extent prudent and determinable" (16 USC 1533(b)(1)(A)). The ESA defines critical habitat as those specific areas that are essential to the conservation of a listed species and that may be in need of special consideration. Federal agencies are prohibited from undertaking actions that destroy or adversely modify designated critical habitat. Some species, primarily the cetaceans, which were listed in 1969 under the Endangered Species Conservation Act and carried forward as endangered under the ESA, have not received critical habitat designations.

Federal agencies have an affirmative mandate to conserve listed species (Rohlf 1989). One assurance of this is federal actions, activities or authorizations (hereafter referred to as federal action) must be in compliance with the provisions of the ESA. Section 7 of the act provides a mechanism for consultation by the federal action agency with the appropriate expert agency, NOAA Fisheries or USFWS. Informal consultations, resulting in letters of concurrence, are conducted for federal actions that have no adverse affects on the listed species. Formal consultations, resulting in biological opinions, are conducted for federal actions that may have an adverse affect on the listed species. Through the biological opinion, a determination is made as to whether the proposed action poses "jeopardy" or "no jeopardy" of extinction to the listed species. If the determination is that the action proposed (or ongoing) will cause jeopardy, reasonable and prudent alternatives (RPAs) may be suggested that, if implemented, would modify the action to no longer pose the jeopardy of extinction to the listed species. The RPAs must be incorporated into the federal action if it is to proceed. A biological opinion with the conclusion of no jeopardy may contain a series of management measures intended to further reduce negative impacts to the listed species. These management alternatives are advisory to the action agency (50 CFR 402.24(j)). If a likelihood exists of any taking occurring during promulgation of the action, an incidental take statement may be appended to a biological opinion to provide for the amount of take that is expected to occur from normal promulgation of the action. An incidental take statement is not the equivalent of a permit to take. The term "take" under the ESA means "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct" (16 USC 1538(a)(1)(B)).

Twenty-five species occurring in the BSAI and/or GOA groundfish management areas are currently listed as endangered or threatened under the ESA (Table 3.4-1): seven great whales, one pinniped, 13 Pacific salmon, three birds, and one turtle.

In summary, species listed under the ESA are present in the management area and, as detailed in this section, some are negatively affected by groundfish fishing, the subject of this Programmatic SEIS federal activity. NOAA Fisheries is the expert agency for ESA-listed marine mammals. The USFWS is the expert agency for ESA-listed seabirds. The proposed action, continuation of the federal groundfish fisheries in the 200-mile EEZ off Alaska, must be in compliance with the ESA.

The material presented in the subsections that follow further explains the ESA and ESA Section 7 consultations that have occurred prior to preparation of this Programmatic SEIS, and describes listed species present in the management (e.g., action) area.

Section 7 Consultations

Because groundfish fisheries are federally regulated, any negative effects of the fisheries on ESA-listed species or critical habitat and any takings that may occur are subject to ESA Section 7 consultation. NOAA Fisheries initiates the consultation, with itself for marine mammals and anadromous fish and with the USFWS for birds. The resulting letters of concurrence and biological opinions are issued to NOAA Fisheries. NPFMC may be invited to participate in the compilation, review, and analysis of data used in the consultations. The determination of whether the action "is likely to jeopardize the continued existence of" endangered or threatened species or to result in the destruction or modification of critical habitat, however, is the responsibility of either NOAA Fisheries or USFWS. If the action is determined to result in jeopardy, the opinion includes reasonable and prudent measures that are necessary to alter the action to avoid jeopardy. If an incidental take of a listed species is expected to occur under normal promulgation of the action, an incidental take statement is appended to the biological opinion.

For all ESA listed species, Section 7 consultation must be reinitiated if the amount or extent of taking specified in the incidental take statement is exceeded; new information reveals effects of the action that may affect listed species in a way not previously considered; the action is subsequently modified in a manner that causes an effect to listed species that was not considered in the biological opinion; or a new species is listed or critical habitat is designated that may be affected by the action.

Section 7 consultations have been done for all the above listed species: some individually and some as groups. Below are summaries of species that are not described in their own independent section (e.g., marine mammals, seabirds, etc.), Section 7 consultations have been included in the descriptions.

3.4.1 Leatherback Turtle (*Dermochelys coriacea)*

Life History and Distribution

Leatherback turtles are the largest sea turtles in the world, reaching a shell length of 1.6 m and a mass of 700 kg. They reach sexual maturity at an estimated age of 13 to 14 years for females and live for more than 30 years (Zug and Parham 1996). Leatherbacks must surface to breathe air but can stay submerged for 2 hours and dive to 1000 m. Males do not leave the ocean but females come ashore on open, sandy beaches to dig nests and lay eggs. Nestlings emerge from the sand at night and attempt to make their way to the sea. Very little is known about the distribution and natural history of these young turtles after they leave their natal beaches.

Leatherback turtles are widely distributed throughout the world's oceans (Ernst and Barbour 1989). In the Pacific Ocean, they range as far north as Alaska and as far south as Chile and New Zealand. In Alaska, leatherback turtles are found as far north as 60°34'N, 145°38'W (Copper River delta) and as far west as the Aleutian Islands (Hodge 1979, Stinson 1984). Leatherback turtles have also been found in the Bering Sea along the coast of Russia (Bannikov *et al.* 1971). The Pacific coast of Mexico is generally regarded as the most important breeding ground for nesting leatherback turtles in the world. No nesting is known to occur in U.S. waters of the Pacific. Nesting is widely reported from the western Pacific, including China, southeast Asia, Indonesia, and Australia.

Leatherback turtles undertake the longest migrations and exhibit the broadest thermal tolerances among sea turtles (NMFS and USFWS 1995). Leatherback turtles have been found in waters ranging from 7° to 27° C in temperature (Shoop and Kenney 1992). Leatherback turtles are typically associated with continental shelf habitats and pelagic environments, and are sighted regularly in offshore waters (deeper than 328 ft).

Estimating the population size of this species is especially difficult because individuals are widely dispersed and males never come ashore. Population estimates are usually based on the number of females seen on nesting beaches. These counts are also problematic because females frequently change beaches. In spite of the difficulty in censussing their numbers, it is clear that the population of leatherback turtles is declining significantly. The global leatherback turtle population was estimated to number approximately 115,000 adult females in 1980 (Pritchard 1982), but only 34,500 in 1995 (Spotila *et al.* 1996). The Pacific leatherback population appears to be in a critical state of decline. The eastern Pacific leatherback population was estimated to be over 91,000 adults in 1980 (Spotila *et al.* 1996), but is now estimated to number less than 3,000 total adult and subadult animals (Spotila *et al.* 2000). Leatherback turtles have experienced major declines at all major Pacific basin rookeries (Sarti *et al.* 1996, Spotila *et al.* 2000). In the western Pacific, the decline is equally severe. Current nestings at Terengganu, Malaysia, represent one percent of the levels recorded in the 1950s (Chan and Liew 1996).

Trophic Interactions

Leatherback turtles feed predominately on jellyfish and other large planktonic species (siphonophores and salpae) in temperate and boreal latitudes (NMFS and USFWS 1998). There is little information available on their diet in subarctic waters. To a large extent, the oceanic distribution of leatherback turtles may reflect the distribution and abundance of their planktonic prey. Adult leatherbacks do not have many natural predators although killer whales are known to eat adult leatherbacks off the coast of Mexico (Sarti *et al.* 1991). Nestling and juvenile turtles fall prey to a host of bird, mammal, and fish species throughout their range, especially coastal and pelagic sharks.

Wildlife Management Responsibility

NOAA Fisheries and the USFWS share responsibilities at the federal level for the research, management, and recovery of Pacific sea turtle populations under U.S. jurisdiction. The leatherback turtle was listed as "endangered" under the ESA in June of 1970. NOAA Fisheries and USFWS have created a joint Pacific Sea Turtle Recovery team to develop a recovery plan for the species (NMFS and USFWS 1998). Under the requirements of the ESA, these agencies are responsible for issuing Section 7 consultations (Biological Opinions) for federal actions that may impact the species, such as the BSAI and GOA Groundfish FMPs.

Leatherback turtles are classified as Critically Endangered in the International Union for Conservation of Nature's *Red List of Threatened Species* (IUCN 2000), where taxa so classified are considered to be "facing an extremely high risk of extinction in the wild in the immediate future". In October of 2000, the U.S. ratified the Inter-American Convention for the Protection and Conservation of Sea Turtles. This treaty is the first international agreement dedicated solely to raising standards for the protection of sea turtles.

Past/Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Nesting on open, sandy beaches, leatherback turtles are susceptible to a number of human activities including beachfront development that results in habitat loss. In some areas, adults are taken for meat and oil. The poaching of eggs from nests continues in many areas including the U.S. Virgin Islands and Puerto Rico. On some beaches, nearly 100 percent of the eggs laid have been harvested (Eckert 1996). Many of these eggs end up on the black market for sale as aphrodisiacs.

The setting of "large mesh nets suitable for turtling" is common in the waters off Puerto Rico. Although the practice was outlawed in 1984, it still continues illegally. The nets are intended for hawksbills and green turtles, but leatherbacks occasionally become entangled (NMFS and USFWS 1998).

Direct and Indirect Effects of External Fisheries

Leatherback turtles have been strongly impacted by commercial fisheries. The primary threats are entanglement in fishing gear (e.g., driftnets, longlines, lobster pots, weirs), boat collisions, contamination by oil spills, and ingestion of marine debris (Eckert 1996, Spotila *et al.* 1996, NMFS and USFWS 1998). Although some driftnet fisheries, particularly shrimp trawlers, are required to use Turtle Exclusion Devices, leatherbacks are too big for most commercially available devices and are drowned in nets even if they are equipped with Turtle Exclusion Devices. Spotila *et al.* (2000) state that a conservative estimate of annual leatherback fishery-related mortality (from longlines, trawls, and gillnets) in the Pacific during the 1990s was 1,500 animals. They estimate that this represented about a 23 percent mortality rate (or 33 percent if most mortality was focused on the east Pacific population). Based on recent modeling efforts, the leatherback turtle population cannot withstand more than a one percent human-related mortality level, which translates to 150 nesting females (Spotila *et al.* 1996; Spotila, personal communication). The model simulations indicated that leatherbacks could maintain a stable population only if both juvenile and adult survivorship remained high, and that if other life history stages (i.e., egg, hatchling, and juvenile) remained static. Characterizations of this population suggest that it has a very low likelihood of survival and recovery in the wild under current conditions.

Direct and Indirect Effects of the BSAI/GOA Groundfish Fisheries

NOAA Fisheries Protected Resources Division issued a Biological Opinion in November 2000 on the interaction of leatherback turtles and the BSAI/GOA groundfish fishery (NMFS 2000c). In that document, NOAA Fisheries noted that the GOA groundfish FMP area is at the extreme edge of the leatherback turtle's historic range. They occur generally as stranded animals along the coastlines of Southeast Alaska and are not considered to be frequent visitors to the GOA fishing grounds or found in the BSAI FMP area at all. According to NOAA Fisheries, there have been no direct takes of leatherbacks in the commercial fisheries in the BSAI and GOA. NOAA Fisheries has no information to assess the potential competition or cascade

effects of the fisheries on the trophic level of leatherbacks, either positively or negatively. There is no fishery that is targeting the prey of this species. NOAA Fisheries concludes that the direct and indirect effects of commercial fisheries in the BSAI and GOA on leatherback turtles is negligible and not likely to jeopardize its survival or recovery.

Comparative Baseline

Leatherback turtle populations are in serious decline around the world, largely due to many human-related sources of mortality. All of them must be addressed if this species is to recover from the brink of extinction (NMFS and USFWS 1998). Although some commercial fisheries have played a major role in the decline of this species, NOAA Fisheries has concluded that the BSAI and GOA groundfish fisheries have negligible effects, if any, on the species (NMFS 2000c).

Status for Cumulative Effects Analysis

Leatherback turtles rarely enter the waters fished by the BSAI/GOA groundfish fisheries and do not appear to be affected in any direct or indirect manner by the fisheries. Since the groundfish fisheries do not contribute to the cumulative effects on the species, leatherback turtles will not be carried forward for analysis in Chapter 4.

3.4.2 Pacific Northwest Salmon

Five species of Pacific salmon, pink (*Oncorhynchus gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), coho (*O. kisutch*) and chinook salmon (*O. tshawytscha*), as well as steelhead trout (*O. mykiss*) occur in Alaska.

Refer to Section 3.5.2.2 for Pacific salmon life history and trophic interaction information. This section will explain the relationship between the BSAI and GOA groundfish fisheries and Northwest Pacific salmon. For a thorough description of Northwest Pacific salmon distribution, management and past/present effects within its habitat of origin, refer to the NOAA Fisheries Draft Programmatic EIS for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California and in the Columbia River Basin (NMFS 2002)

Pacific Northwest Salmon Management

Pacific salmon off the Alaska coast are managed under a complex mixture of domestic and international bodies, treaties, regulations, and other agreements. Federal and State agencies cooperate in managing salmon fisheries. The Alaska Department of Fish & Game (ADF&G) manages salmon fisheries within state jurisdictional waters, where the majority of harvest occurs. Management in the EEZ is the responsibility of NPFMC. Under Amendment 4 of the Federal Salmon FMP regulation of the directed salmon fishery occurring in the EEZ off Southeast Alaska is deferred to the State of Alaska (NPFMC 1990). Management of Alaska salmon fisheries is based primarily on regional stock groups of each species and on time and area harvesting by specific types of fishing gear. Over 25 different commercial salmon fisheries in Alaska are managed with a special limited-entry permit system that specifies when and what type of fishing gear can be used in each area. These fisheries, extending from Dixon Entrance in Southeast Alaska to Norton Sound in the Bering Sea, are allowed to catch salmon in different fisheries, either with drift gillnets, set gillnets, beach seines, purse seines, hand troll, power troll, or fish wheel harvest gear. Sport fishing is limited to hook-and-

line, while subsistence fishermen may use gillnets, dip nets, or hook-and-line. Some subsistence harvesting of salmon is also regulated by special permits.

The Southeast Alaska salmon fisheries have the largest impact on the Pacific Northwest salmon, relative to other Alaska salmon fisheries. Only Southeastern Area A is open to commercial salmon fishing, although there are three minor fisheries in the Yakutat Area D. These salmon fisheries are regulated by ADF&G and adhere to the FMP for the Salmon Fisheries off the Coast of Alaska (NPFMC 1990), the MSA, the Pacific Salmon Treaty (see below), and the ESA when applicable, along with other federal laws. Sport fisheries also occur in Southeast Alaska, and are managed by ADF&G. Anglers are required to obtain a fishing license, restrictions vary for each salmon species. ADF&G also monitors subsistence and personal use permits in Southeast Alaska.

Salmon fisheries are managed to meet an escapement goal of a certain number of spawners for each river system. Meeting escapement goals is considered equivalent to maintaining healthy stocks. In general, spawners are counted on their way upstream, after their numbers have already been reduced by natural mortality at sea, bycatch at sea, and directed fisheries downstream.

International Management

Some fisheries, including the Southeast Alaska chinook, coho, and sockeye fisheries, have harvest limits that are subject to negotiations between the U.S. and Canada under the Pacific Salmon Treaty. This treaty originally signed in 1983 also covers salmon that are intercepted in fisheries that are returning to Idaho, Oregon, and Washington. In recent years, the treaty process was stalled due to disagreements between the two countries on allocations for certain fisheries and species. In 1999, a new harvest agreement was signed. The new treaty specified new harvest limits for both countries. In recent years, the treaty process was stalled due to disagreements between the two countries on allocations for certain fisheries and species. The new agreement provides stability to the fisheries of both countries. The agreements are complex and require continuous coordination between both countries to be successful. The new treaty will expire, unless renewed, in 2008.

On a broader international scope, the management of salmon harvest in the high seas of the North Pacific Ocean from 1957 to 1992 was authorized by the International North Pacific Fisheries Commission (INPFC), and via bilateral and multilateral agreements and negotiations with Taiwan and the Republic of Korea (South Korea). In 1993, the North Pacific Anadromous Fish Commission was formed to replace the International North Pacific Fisheries Commission. This four-country commission (Canada, Japan, the Russian Federation, and the U.S.) now provides a framework for international cooperation in salmon management and research in the North Pacific Ocean. The North Pacific Anadromous Fish Commission Convention prohibits high seas salmon fishing and trafficking of illegally caught salmon. Coupled with United Nations General Assembly Resolution 46/215, which bans large-scale pelagic driftnet fishing in the world's oceans, harvesting of Pacific salmon on the high seas, except for illegal fishing, no longer occurs. This allows for effective management control to fully return to the salmon-producing nations.

NOAA Management

There are no GOA FMP amendments that directly address salmon bycatch. However, while PSC limits have not been established for salmon, the timing of seasonal openings for the pollock fisheries in the central and western GOA have been adjusted to avoid periods of high chinook and chum salmon bycatch.

Endangered Species Act

No stocks of Pacific salmon originating from freshwater habitat in Alaska are listed under the ESA. The ESA listed species or evolutionary significant units (ESUs) that migrate into marine waters off Alaska, originate in freshwater habitat in Washington, Oregon, Idaho, and California. In the marine waters off Alaska, the ESA listed salmon stocks are mixed with hundreds to thousands of other stocks originating from the Columbia and Willamette Rivers, British Columbia, Alaska, and Asia. The ESA-listed fish are not visually distinguishable from the other, unlisted, stocks. Mortal take of them in the salmon bycatch portion of the fisheries is assumed based on limited abundance, timing, and migration pattern information gleaned from recovery locations of coded-wire-tagged surrogate stocks (closely related hatchery stocks that are tagged with coded wire tags). For information on PSC limits and commercial salmon fishery catch limits set in Alaska waters by NOAA Fisheries and ADF&G, see Section 3.5.2.2.

Pacific Northwest Salmonid Past/Present Effects Analysis

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document.

The following direct and indirect effect indicators were identified as potentially having population level effects on Northwest Pacific salmon:

- Catch/bycatch of Northwest Pacific salmon (direct effect)
- Reduced/Increased Recruitment due to Hatchery Programs (indirect effect)
- Reduced Recruitment due to Habitat degradation (indirect effect)
- Reduced/Increased Recruitment due to Climate Changes and Regime Shifts (indirect effect)

The past/present events determined to be applicable to the Pacific salmon past/present effects analysis include the following:

- Past/Present External Events
  - State of Alaska Directed Salmon Fisheries (commercial and sport fisheries)
  - Washington, Oregon, California Coast Groundfish Fisheries (NMFS 1999i)
  - Washington, Oregon and California State Salmon Fisheries (NMFS 1999i)
  - Alaska Subsistence Fisheries
  - Foreign Fisheries (pre-MSA)
  - Hatchery Programs (NMFS 1999i)
  - Habitat Degradation (NMFS 1999i)
  - Hydro-development (NMFS 1999i)
  - Climate Changes and Regime Shifts

- Past/Present Internal Events
  - BSAI and GOA Groundfish Fisheries

- Past/Present Management Actions
  - ADF&G Management
  - Washington, Oregon, and California State Management
  - International Agreements

- Endangered Species Act (Section 7 Consultation)
- Federal, State and Local Agencies associated with salmon habitat
- Foreign Fisheries Management
- Industry Self-Imposed Management
- FMP Groundfish Fisheries Management

Washington, Oregon and California State Salmon Fisheries and Groundfish Fisheries and salmon hatchery programs have not been brought forward for past/present effects analysis. For a thorough description of these fisheries and their impacts on the Northwest Pacific Salmon, see the November 1999 Endangered Species Act - Reinitiated Section 7 Consultation, Biological Opinion (NMFS 1999i).

The quality of salmon spawning habitat is influenced by land management practices (e.g., forestry practices, agricultural practices and urbanization) and climatic events (e.g. flooding that scours streams). Several agencies, entities, and groups exert control over watersheds used by spawning salmon. NOAA Fisheries designated critical habitat in 1993 (57 Federal Register [FR] 57051) for the Snake River sockeye, Snake River spring/summer chinook, and Snake River fall chinook salmon. The designations did not include any marine waters, and therefore does not include any habitat where Alaska groundfish fisheries are promulgated. For a thorough analysis of habitat degradation and hydro-development impacts on Northwest Pacific Salmon, see the November 1999 Endangered Species Act - Reinitiated Section 7 Consultation, Biological Opinion (NMFS 1999i).

External Mortality: Catch/bycatch by State of Alaska Directed Salmon Fisheries

The commercial salmon fisheries in Southeast Alaska began in the late 1870s, primarily targeting sockeye salmon. Pink salmon began to dominate in early 1900s and has continued to dominate into recent years. Salmon catch has increased since the mid-1970s with more diverse catches of salmon including pink, chum, coho and sockeye salmon. Catches of chinook salmon have been limited in recent years due to harvest limits imposed by the Pacific Salmon Treaty. Trawlers take a majority of the salmon catch in southeast; drift and set gillnet and purse seine fishers only operate within state waters.

The list of ESA-listed salmon stocks as of 2002 is in Table 3.4-1. Those stocks that are likely to migrate into marine waters off Alaska are highlighted: they include six ESUs of chinook salmon, one ESU of chum salmon, and five ESUs of steelhead (i.e. Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Upper Columbia River spring chinook, Columbia River chum, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River basin steelhead).

Incidental take of listed salmon species likely to range into Alaskan waters in the Southeast Alaskan fisheries are limited by the Pacific Salmon Treaty. Bycatch varies from year to year, dependent upon abundance of salmon stock and established catch limits. The November 1999 Biological Opinion (NMFS 1999i) determined Southeast Alaskan fishery bycatch is not at a level that is likely to jeopardize any of the Northwest Pacific Salmon ESUs. However, ADF&G is still required to implement reasonable and prudent measures under the ESA as follows:

- Management objectives (pre-season and inseason) established for the Southeast Alaska fisheries must be consistent with the provision established by the Pacific Salmon Treaty.

- ADF&G must monitor catch and implementation of management measures in the Southeast Alaska fisheries.

- ADF&G with NOAA Fisheries Alaska Region and NPFMC chair must sample the Southeast Alaska fishery catch to determine stock composition and gather biological information intended to determine fishery-related impacts on listed ESUs.

External Mortality: Alaska Subsistence Fisheries

Harvest of Northwest Pacific Salmon by Alaskan and Pacific Northwest subsistence groups probably occurs, although their impacts on the ESA listed salmon stocks is likely to be minimal.

External Mortality: BSAI and GOA Foreign Groundfish Fisheries (pre-MSA) Bycatch

Although it is impossible to determine the number of Northwest Pacific salmon taken by the BSAI and GOA foreign groundfish fisheries prior to the MSA, it is assumed that bycatch of salmon per region per year was substantially higher than what occurs currently.

Internal Mortality: BSAI and GOA Groundfish Fisheries (post-MSA) Bycatch

Pacific Northwest chinook salmon stocks may compose a larger proportion of GOA bycatch than they do of BSAI bycatch (Personal Communication with Kate Myers, NMFS Auke Bay, 2003). While some Pacific Northwest stocks are listed as endangered or threatened under the ESA (Table 3.4-1), none of the catches observed in Alaska would exceed the incidental take limit of 40,000 fish accepted under ESA Section 7 consultation.

The effects of the BSAI and GOA groundfish fisheries on listed salmon were considered through informal consultations with NOAA Fisheries (February 20, 1992; April 21, 1993; June 7, 1993; and September 22, 1993) and by formal consultations (NMFS, 1994, 1995a, and 1999e). Each consultation is summarized below, beginning with the informals and moving through the formals in order of issuance. Informal consultations were done on fishing years 1992 and 1993 (February 20, 1992 and April 21, 1993, respectively), and on BSAI Amendment 28 (June 7, 1993) and GOA Amendment 31 (September 22, 1993).

In the latter two informal consultation memorandums, NOAA Fisheries stated that it was essential that monitoring efforts be continued and that NOAA Fisheries continue to seek additional information regarding potential impacts to listed fish.

The 1994 biological opinion was the first formal consultation considering whether continuation of the groundfish fisheries in the BSAI and GOA in 1994 and beyond was likely to jeopardize the continued existence of Snake River sockeye salmon, Snake River spring/summer chinook salmon, or Snake River fall chinook salmon. Assessment of impacts in the biological opinion established approaches for evaluating the proposed actions. Using those approaches, effects of the proposed action on the listed species were evaluated. Effects are expressed in terms of numerical catch assessment, base period analysis (1986 to 1990), cumulative effects analysis, and combined effects analysis. For purposes of the analysis, it was assumed that annual bycatch of chinook salmon in 1994 and for the foreseeable future would be 40,000 or fewer fish in each of the BSAI and GOA groundfish fisheries. Relative to the base period analysis question, the assumed maximum bycatch of 40,000 chinook salmon per region per year is substantially less than that which occurred

in the foreign and joint venture fisheries in earlier years. No cumulative effects accruing to the listed species of activities occurring within the action areas are thought to exist (NMFS 1994).

In the biological opinion, NOAA Fisheries "determined that it is highly unlikely that any Snake River sockeye salmon are taken in the groundfish fisheries. Based on that, NOAA Fisheries concluded that the groundfish fisheries are not likely to adversely affect Snake River sockeye salmon and thus will not jeopardize their continued existence." For listed chinook salmon, "NOAA Fisheries concluded that the catch of Snake river spring/summer chinook salmon is unlikely to average more than one fish per year in each region, and that it is highly unlikely than any Snake River fall chinook salmon are taken in the BSAI groundfish fisheries." NOAA Fisheries concluded that the catch of Snake River fall chinook in the GOA groundfish fisheries "is unlikely to average more than five fish per year and may be substantially less." Based on available information, NOAA Fisheries concluded "the groundfish fisheries are not likely to jeopardize the continued existence of any of the ESA listed salmon" (NMFS 1994). The 1994 biological opinion contained four conservation recommendations:

1. NPFMC and NOAA Fisheries, Alaska Region should monitor the bycatch of chinook salmon in the groundfish fisheries and take necessary actions to ensure that the bycatch is minimized to the extent possible and in any case does not exceed 40,000 chinook salmon per year in either the BSAI or GOA groundfish fisheries.

2. NPFMC and NOAA Fisheries, Alaska Region should improve estimates of the region-of-origin and stock composition of the chinook salmon bycatch by increasing Coded Wire Tag sampling rates as part of the mandatory salmon retention program, collecting and analyzing scale samples, and employing additional stock identification techniques applicable to the problem.

3. NPFMC and NOAA Fisheries, Alaska Region should use information collected during the observer monitoring program to identify times and areas of high salmon abundance that could be used to reduce salmon bycatch through regulatory action.

4. NPFMC and NOAA Fisheries, Alaska Region should encourage development of incentive programs designed to reduce the bycatch of salmon in the BSAI and GOA groundfish fisheries.

The incidental take statement appended to the biological opinion allowed for take of five Snake River fall chinook in the GOA, zero in the BSAI, one take of Snake River spring/summer chinook in the BSAI and GOA fisheries, and zero take of Snake River sockeye in either fishery, per year. As explained above, it is not technically possible to know if any have been taken. Compliance with the biological opinion was stated in terms of limiting salmon bycatch per year to under 40,000 fish per year for chinook salmon, and 200 and 100 fish per year for sockeye salmon in the BSAI and GOA fisheries, respectively (NMFS 1994). Keeping salmon bycatch within these limits is presumed to reduce the probability of incidental catch of listed salmon to near-zero.

Three terms and conditions were to be implemented by NOAA Fisheries Alaska Region to carry out the reasonable and prudent measures established under the incidental take statement.

- NOAA Fisheries Alaska Region shall continue to implement the current observer program for the BSAI and GOA groundfish fisheries. Mothership processor vessels or shoreside processing facilities that process 1,000 mt per day or more must have a NOAA Fisheries certified observer on board the

vessel or at the facility each day it receives or processes groundfish. Motherships or shoreside processing facilities th at process 500 to 1,000 mt per day must have a NOAA Fisheries certified observer for at least 30 percent of the days it receives or processes fish. Catcher processor or catcher vessels 125 feet (ft) in length overall (LOA) or longer are required to have a groundfish observer onboard for 100 percent of their fishing days. Vessels from 60 to 124 ft LOA are required to have a groundfish observer onboard for 30 percent of their fishing days. Vessels under 50 ft LOA are not required to carry groundfish observers.

- NOAA Fisheries Alaska Region shall monitor the year -to-date bycatch estimates of chinook salmon on a weekly basis. If it is anticipated inseason that the annual total bycatch of chinook salmon will exceed 40,000 fish in either the BSAI or GOA fisheries, NPFMC and NOAA Fisheries, Alaska Region should reinitiate consultation.

- NOAA Fisheries Alaska Region shall estimate and report the bycatch of sockeye salmon annually as part of the post season analysis. If the annual bycatch of sockeye exceeds 200 fish in the BSAI or 100 fish in the GOA fishery, consultation shall be reinitiated (NMFS 1994).

A second biological opinion was issued in 1995 (NMFS 1995a), to reflect new information pertinent to the assumption that the bycatch of chinook salmon in the BSAI and GOA would not exceed 40,000 fish per year in either region. The estimated bycatch of chinook in the BSAI area was 44,487 in 1994, and revised estimates for the number of chinook salmon taken in the years 1991-1993 were greater than 40,000 fish per year (in 1993, 46,014; 1992, 41,955; and 1991, 48,880), thus exceeding the terms of the incidental take statement. The purpose of the reinitiated consultation was to consider whether this new information affected the previous conclusion that the BSAI groundfish fisheries were not likely to jeopardize the continued existence of Snake River spring/summer or fall chinook salmon. Conclusions regarding impacts to sockeye salmon the BSAI and GOA groundfish fisheries and chinook salmon in the GOA were not reviewed because the new information did not pertain to those species or areas.

In the 1995 biological opinion conclusions, NOAA Fisheries reiterated its previous conclusions that NPFMC regulated groundfish fisheries were not likely to adversely affect Snake River sockeye salmon and thus could not jeopardize their continued existence. Based on the available information, NOAA Fisheries also concluded that the groundfish fisheries were not likely to jeopardize the continued existence of Snake River spring/summer chinook salmon or Snake River fall chinook salmon (NMFS 1995a).

The first conservation recommendation contained in the January 19, 1994, biological opinion was revised (as reproduced below). The remaining conservation recommendations (numbers 2 through 4) remain in effect.

1. NPFMC and NOAA Fisheries Alaska Region should monitor the bycatch of chinook salmon in the groundfish fisheries and take necessary actions to ensure that the bycatch is minimized to the extent possible an d in any case does not exceed 55,000 chinook per year in the BSAI fisheries or 40,000 chinook salmon per year in the GOA fisheries. (NMFS 1995a).

Also the second of the three terms and conditions to the incidental take statement was modified (as follows) to reflect the increase in the estimate of chinook bycatch in the BSAI.

2. NOAA Fisheries, Alaska Region shall monitor the year-to-date bycatch estimates of chinook salmon on a weekly basis. If it is anticipated inseason that the annual total bycatch of chinook salmon will

exceed 55,000 fish in the BSAI fisheries or 40,000 fish in the GOA fisheries, NPFMC and NOAA Fisheries, Alaska Region should reinitiate consultation. (NMFS 1995a).

A third biological opinion was issued on December 22, 1999 (NMFS 1999e). The reasons for reinitiation of consultation were the new (1997 and 1999) listings of a number of salmon ESUs under the ESA (Table 3.4-1). After reviewing the status of Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Lower Columbia River chinook, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River basin steelhead, the environmental baseline for the action area, the effects of the proposed fishery and the cumulative effects, NOAA Fisheries determined that the BSAI and GOA groundfish fisheries subject to the BSAI FMP groundfish fishery and the GOA groundfish FMP, as proposed was not likely to jeopardize their continued existence.

The incidental take statement appended to the biological opinion allowed for take of 55,000 chinook salmon in the BSAI and 40,000 chinook salmon in the GOA. No take of Hood Canal summer run chum or Lower Columbia River chum was expected in BSAI or GOA groundfish fisheries. NOAA Fisheries does not anticipate that the proposed fisheries will take any coho from the southern Oregon/northern California coast or central California ESUs, any Snake River or Lake Ozette sockeye salmon, or any steelhead ESUs (NMFS 1999e).

Two reasonable and prudent measures were provided to minimize and reduce the anticipated level of incidental take associated with NPFMC-regulated groundfish fisheries:

1. NPFMC and NOAA Fisheries, Alaska Region shall ensure there is sufficient NOAA Fisheries-certified observer coverage such that the bycatch of chinook salmon and “other” salmon in the BSAI and GOA groundfish fisheries can be monitored on an in season basis.

2. NPFMC and NOAA Fisheries, Alaska Region shall monitor bycatch reports inseason to ensure that the bycatch of chinook salmon does not exceed 55,000 fish per year in the BSAI fisheries and 40,000 fish per year in the GOA fisheries (NMFS 1999e).

In order to be exempt from the prohibitions of Section 7 of the ESA, the specified agencies must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

- NOAA Fisheries, Division of Sustainable Fisheries (Alaska Region) shall provide an annual report to the Division of Protected Resources (Alaska Region) that details the results of its monitoring of bycatch reports during each fishing season. These reports shall be submitted in writing within one month of the new fishing year (February 1), and will summarize all statistical information based on a January 1 through December 31 fishing year (NMFS 1999e).

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might result from the proposed action. If, during the course of the groundfish fishery, this level of incidental take is exceeded, the additional level of take would represent new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided above.

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further its purposes by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to develop additional information, or to assist federal agencies in complying with their obligations under ESA Section 7(a)(1). NOAA Fisheries believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented by NPFMC and NOAA Fisheries:

- NPFMC and NOAA Fisheries, Alaska Region should improve estimates of the region-of-origin and stock composition of the chinook salmon bycatch by increasing CWT sampling rates as part of the mandatory salmon retention program, collecting and analyzing scale samples, and employing additional stock identification techniques applicable to the problem.

- NPFMC and NOAA Fisheries, Alaska Region should use information collected during the observer monitoring program to identify times and areas of high salmon abundance that could be used to reduce salmon bycatch through regulatory action.

- NPFMC and NOAA Fisheries, Alaska Region should encourage development of incentive programs designed to reduce the bycatch of salmon in NPFMC groundfish fisheries (NMFS 1999e).

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NOAA Fisheries requested notification of the implementation of any conservation recommendations.

External Reduced Recruitment: Commercial Seal Harvesting and Commercial Whaling

Currently, the effects of rebounding seal and whale populations on salmon mortality, especially chinook salmon, are not well understood. Commercial whale and seal harvest were banned in 1972 with the passing of the Marine Mammal Protection Act (MMPA). Presently, foreign and subsistence whale harvests are monitored by the International Whaling Commission (IWC) (NMFS 1999i).

External Increased/Reduced Recruitment: Climate Changes and Regime Shifts

Various climate factors, including ENSO , have had different affects on the northwest Pacific salmon populations. Included climate factors are severe flooding, droughts, and change in ocean productivity. In the Northwest Pacific, researchers have found that salmon may be responding to the Pacific Decadal Oscillation, a 20 to 30 year cycle of climate conditions and ocean productivity (Mantua *et al.* 1997). Response to these climate changes depends upon the stock and its timing and distribution. Overall, it appears that northwest Pacific salmon may have been negatively affected in this phase of the cycle. One example is the Puget Sound chinook stocks which dropped to half of their 1974 to 1977 broods in 1979 (Cramer 1999).

Northwest Pacific Salmon Comparative Baseline

Southeast salmon stocks reached their highest levels in the 1980s and 1990s (Rogers 1987, Wertheimer 1997); spawning escapement has increased since the 1970s and have reached escapement objectives in recent years. Of the 407 chinook stocks harvested in the Southeast, 81 percent are classified as not threatened, and 15 percent are special concern or at risk (Slaney *et al.* 1996). Large portions of the Southeast 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 Southeast harvest, and nearly all coho salmon harvested originate from Alaskan streams (Weitkamp *et al.* 1995).

For current status information on West Pacific Coast and Columbia River Basin salmon stocks, refer to the Northwest Region Draft Programmatic Environmental Impact Statement for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California, and in the Columbia River Basin, Chapter 3 – Affected Environment, Section 3.4 and 3.5 (NMFS 2002).

Northwest Pacific Salmon Cumulative Effects Analysis Status

Due to the limited impacts of the BSAI and GOA groundfish fisheries on Northwest Pacific Salmon, these stocks will not be brought forward for cumulative effects analysis. For up-to-date information on the status of these stocks and their habitat, visit the NOAA Fisheries Northwest Region website at www.nwr.noaa.gov. Comments on the Northwest Region Draft Programmatic Environmental Impact Statement for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California, and in the Columbia River Basin were due November 22, 2002. Biological opinions, fishery management plans, Environmental Impact Statements, and other informative documents involving these stocks are also available on the Northwest Region website.