4.9 Analysis of Preferred Alternative

The following discussions describe the analyses of expected direct, indirect, and cumulative effects of the Preferred Alternative (PA) on all of the resource categories. The potential effects of two policy “bookends” are analyzed, PA.1 and PA.2. These bookends represent the policy boundaries of the PA. As actually implemented, the PA could include policy measures anywhere within the range between the two bookends. The PA is described in detail in Section 2.6.9.

4.9.1 Target Groundfish Species

This section examines the potential direct, indirect, and cumulative effects that the implementation of the PA is expected to have on the target groundfish species. The impact analyses start with the baseline (2002) status of the BSAI and GOA target groundfish stocks described in Section 3.5.1, including past trends that are likely to persist into the foreseeable future. Then, a computer-based analytic model is used to project how specific characteristics of the target groundfish stocks would respond directly and indirectly to management actions under PA.1 and PA.2. These projections from the model are the predicted direct and indirect effects (impacts) of the FMP on the target groundfish stocks. Section 4.1.5 describes the analytic model and explains how it is applied.

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

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

Direct Effects

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

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

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

Direct and/or Indirect Effects

Habitat Suitability: This is the degree to which habitat has the right characteristics to support the target stock at one or more life-history stages (spawning, rearing of juveniles, availability of food at all stages, availability of refuge areas to allow escape from predators at all stages). Habitat suitability can be affected directly, for example by mechanical damage from bottom trawling, or influenced indirectly, for example by the gradual depletion of corals that provide hard substrate.

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

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

Each of the following subsections presents the model results and rationale for the expected direct and indirect effects of PA.1 and PA.2 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.9-1. Following the direct and indirect effects discussions on each stock, the expected cumulative effects on that stock are evaluated and discussed. The evaluation of potential cumulative effects builds on the direct and indirect effects evaluations as a starting point, and then brings in persistent past effects as well as reasonably foreseeable future natural events and human activities external to fisheries management. The cumulative effects assessment method uses the same impact categories and significance criteria discussed above for direct and indirect effects. This method is described further in Section 4.1.4.

4.9.1.1 Pollock

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

Direct/Indirect Effects of PA.1

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-42 of Appendix H. Under PA.1, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.3 million mt in 2004, then stabilize to about 11.7 million mt. The 2003-2007 average total biomass is 11.5 million mt.

In the Aleutian Islands region, the assessments are based on trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Assuming that under PA.1 there is no directed fishing for pollock in this region (the exploitation level is quite low, <1 percent or an average annual catch of 1,700 mt from 2003-2007), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island.

For GOA pollock, the age 2-10+ biomass is expected to increase under this PA.1 from a 2003 low of 799,000 mt to1,263,000 mt by 2007. The average biomass over this period is expected to be 1,052,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-64 of Appendix H).

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-42 of Appendix H. Under PA.1, projections indicate that EBS pollock spawning biomass will decrease to about 83 percent of the 2002 level by 2007. The projected average for 2003-2007 is 3.07 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Assuming that under PA.1 these regions continue to be managed as bycatch-only, it is expected that the spawning stock size will remain stable or increase in these regions. The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 249,000 mt by 2007 under PA.1. This is above the estimated B_{MSY} level, with an annual average spawning biomass of 193,000 mt from 2003-2007. Model projections of future levels are shown in Table H.4-64 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase to an average 0.230 for the period 2003-2007. These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years (Table H.4-42 of Appendix H). Fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under PA.1 for as long as these areas are managed as bycatch only regions. Average catch in the Aleutian Islands regions from 2003-2007 is estimated at 1,700 mt (Table H.4-43 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.107 in 2003 followed by increases to 0.164 by 2007. The SPR rate in 2002 is estimated at 55 percent and averages about 63 percent for the period 2003-2007 (Table H.4-64 of Appendix H). Under PA.1, harvest control rules reduce the TAC and subsequently reduce the ABC values due to uncertainty in GOA pollock stock biomass information.

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (Jan 20-March). Under FMP PA.1, an average of 1.41 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial and temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period for as long as pollock are managed as a bycatch-only fishery. EBS pollock fisheries may be limited somewhat by Pacific halibut PSC limits and bycatch hotspot areas. PSC limits for Pacific halibut are expected to decrease by 0 to 10 percent in the BSAI under PA.1. These measures may contribute to the spatial/temporal concentration of the fishery, although it is unlikely to be significant.

In the GOA pollock fishery, in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.1. Under PA.1, an average of 69,300 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 108,300 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. The effect of these changes is unknown. The GOA pollock fishery may be limited by Pacific halibut bycatch hotspot areas; however, the effects on the spatial and temporal characteristics of the stock due to this measure should not vary from the baseline.

Status Determination

Under PA.1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years. Under PA.1, the BSAI target fish OY is specified between 1.4 and 2.0 million mt (same as FMP 1 and FMP 3.1). If the sum of the TAC is greater than 2.0 million mt, then the TAC will be adjusted down. This may reduce the EBS pollock TAC, and subsequently the ABC values in future years.

For PA.1, GOA pollock spawning biomass is below the B_{MSY} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007. As mentioned above, harvest control rules implemented under PA.1 reduce the TAC, ABC and OFL values for GOA pollock due to uncertainty in biomass estimates.

Age and Size Composition

Under PA.1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.52 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.09 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under PA.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.1.

Current closure areas would remain under this preferred alternative bookend, including the eastern GOA trawl closure and the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important pollock habitat.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under PA.1 (for the period 2003-2007).

A direct fishery for forage fish would continue to be banned under PA.1, and the $B_{20\%}$ rule would remain since pollock is an important prey species for many members of the BSAI and GOA ecosystem.

See Table 4.9-1 for a summary of the direct/indirect effects on EBS, Aleutian Islands and GOA pollock.

Cumulative Effects of PA.1 – EBS and Aleutian Islands pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS and Aleutian Islands pollock stock is insignificant under PA.1 (see Section 4.9.1.1 direct/indirect effects discussion).

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

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

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

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the EBS and Aleutian Islands pollock stock is expected to be insignificant under PA.1 (see direct/indirect effects discussion in this section).

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

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

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under PA.1, however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

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

- **Direct/Indirect Effects.** The spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.9.1.1 direct/indirect effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** The Russian and State of Alaska pollock fisheries have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. On the other hand, removals in these fisheries, with the exception of the herring fishery, could have a potentially beneficial effect on pollock recruitment by reducing the adult pollock biomass. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible under PA.1 for spatial and temporal concentration; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see the direct/indirect effects above). However, it is determined that PA.1 would have an insignificant effect on pollock prey availability.

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

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on pollock prey species could have potentially beneficial or potentially adverse effects. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-1 are determined to be potentially adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under PA.1; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that PA.1 would have insignificant effects on pollock habitat suitability.

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

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

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

See Table 4.5-1 for a summary of the cumulative effects on EBS and Aleutian Islands pollock under PA.1.

GOA Pollock

Mortality

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

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

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

- **Cumulative Effects.** Cumulative effects are identified for mortality of GOA pollock, but the effects are judged to be insignificant for PA.1. Pollock are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under PA.1 (see the direct/indirect effects discussion).

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

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

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

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

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; it is not possible to predict exactly how the pattern will change. However, for GOA pollock under PA.1, the stock is expected to be above MSST for the years 2003-2007 (see the direct/indirect effects discussion). Therefore, impacts of the spatial and temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.1).

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

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration under PA.1, and are considered insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see the direct/indirect effects section above). However, it is determined that PA.1 would have insignificant effects on pollock prey availability.

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

- **Reasonably Foreseeable Future External Effects.** As described for EBS and Aleutian Islands pollock, climate changes and regime shifts could have potentially adverse or beneficial effects on pollock prey species. Marine pollution has been identified as a reasonably foreseeable external contributing factor. The other fisheries shown on Table 4.5-2 are determined to be potentially adverse contributors since bycatch and catch of forage species is likely to continue.

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

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that PA.1 would have insignificant effects on pollock habitat suitability.

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

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

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under PA.1; however, the effects on the GOA pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-2 for a summary of the cumulative effects on GOA pollock under PA.1.

Direct/Indirect Effects of PA.2

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-42 of Appendix H. Under PA.2, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.26 million mt in 2005, then stabilize to about 11.56 million mt. The 2003-2007 average total biomass is estimated at 11.44 million mt.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Assuming that there is no directed fishing for pollock in this region (the exploitation level is quite low, <1 percent), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island.

For GOA pollock, the age 2-10+ biomass is expected to increase under PA.2 from a 2003 low of 799,000 mt to 1,275,000 mt by 2007. The average biomass over this period is expected to be 1,057,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-64 of Appendix H).

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-42 of Appendix H. Under PA.2, projections indicate that EBS pollock spawning biomass will decrease to about 2.91 million mt by 2007. The projected average for 2003-2007 is 3.03 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Under PA.2 these areas are expected to be managed at bycatch-only levels, thus, we expect the spawning stock size to remain stable or increase in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 254,000 mt by 2007 under PA.2. This is above the estimated B_{MSY} level, with an average annual spawning biomass of 194,700 mt from 2003-2007. Model projections of future levels are shown in Table H.4-64 of Appendix H. Under PA.2, the methods and tools used to collect the biological information necessary to determine spawning stock biomass estimates would be improved. This would reduce uncertainty in stock estimates, and could subsequently induce changes in catch limits, especially for the GOA pollock stock.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase to an average 0.239 for the period 2003-2007. These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years. The proportion of SPR conserved under these mortality rates is 50 percent in 2003, decreasing to 48 percent by 2007; the average implied SPR rate of fishing from 2003-2007 is 48 percent (Table H.4-42 of Appendix H). Under PA.2, pollock are maintained at bycatch-only status, thus the fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than 1 percent (Table H.4-43 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.101 in 2003 followed by increases to 0.142 by 2007. The values for $F_{35\%}$ and $F_{40\%}$ are 0.350 and 0.294, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 65 percent for the period 2003-2007. This fishing mortality rate pattern is due to the fact that under this bookend, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$ (Table H.4-64 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (Jan 20-March). Under PA.2, an average of 1.44 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial and temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period (with an annual average catch of 1,444 mt from 2003-2007). The EBS pollock pelagic trawl fishery may be limited by Pacific halibut PSC limits which are projected to be reduced by 0 to 20 percent in the BSAI under PA.2. Inseason bycatch closures will be reevaluated under this preferred alternative analysis, and has the potential to further restrict the pollock fishery from areas where Pacific halibut bycatch is high.

In the GOA pollock fishery, a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.1. Under PA.2, an average of 64,035 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 96,353 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. The effect of these changes is unknown. The GOA pollock fishery may be limited by Pacific halibut PSC limits which are projected to be reduced by 0-10 percent in the GOA under PA.2. Inseason bycatch closures will be developed in the GOA under this preferred alternative analysis, and have the potential to further restrict the pollock fishery from areas where Pacific halibut bycatch is high.

Status Determination

Under PA.2, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For PA.2, GOA pollock spawning biomass is below the B_{MSY} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Under PA.2, the calculation of OY caps would be determined based on their relevance to current environmental conditions and knowledge of current stock levels. Procedures to account for the uncertainty in estimating ABC for EBS and GOA pollock under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. These changes may increase or reduce catch limits for EBS and GOA pollock in the future. TAC values must be set at levels equal to or less than the ABC for all target species under PA.2.

Age and Size Composition

Under PA.2, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.51 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.13 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.2.

Under PA.2, NPFMC and NOAA Fisheries would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands and GOA as MPAs and no-take reserves across a range of different habitat types (similar to FMP 3.2). Existing closures would be reviewed to see if areas may qualify for MPAs under established criteria. Existing areas may be redefined as gear- or fishery-specific. EFH and HAPC designation would continue under PA.2, as would investigations as to whether fishing has adverse impacts on habitats; mitigation measures would be implemented as necessary. An Aleutian Islands management area would be established under PA.2 to protect coral and live bottom habitats. The 2002 Steller sea lion closures and Aleutian Islands critical habitat designations would be reviewed and modified as suggested by new scientific information. Pollock bottom trawling would be prohibited in the BSAI and GOA under PA.2. Please see the FMP 3.2 map (Figure 4.2-5) described in Section 4.2 for more information. All of these measures may reduce the adverse impacts of fishing gear on important pollock habitat.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under PA.2 (for the period 2003-2007). Forage fish commercial fisheries would continue to be banned under PA.2.

Please see Table 4.9-1 for a summary of the direct/indirect effects on EBS, Aleutian Islands and GOA pollock.

Cumulative Effects of PA.2 – EBS and Aleutian Islands Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS and Aleutian Islands pollock stock is insignificant under PA.2 (see the direct/indirect effects discussion).
- **Persistent Past Effects.** Past effects on EBS and Aleutian Islands pollock mortality are the same as those indicated under PA.1.
- **Reasonably Foreseeable Future External Effects.** Future external effects on EBS and Aleutian Islands pollock mortality are the same as those considered under PA.1.
- **Cumulative Effects.** Cumulative effects are identified for mortality of EBS and Aleutian Islands pollock, but the effects are judged to be insignificant. Pollock are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS and Aleutian Islands pollock stock is expected to be insignificant under the PA.2 (see the direct/indirect effects discussion).
- **Persistent Past Effects.** Past effects on the EBS and Aleutian Islands pollock change in biomass level are the same as those described under PA.1.
- **Reasonably Foreseeable Future External Effects.** Future external effects on EBS and Aleutian Islands pollock change in biomass level are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under PA.2; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

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

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

- **Persistent Past Effects.** Past effects under PA.2 are identical to those described for PA.1 and include lingering beneficial effects on reproductive success.

- **Reasonably Foreseeable Future External Effects.** Future external effects under PA.2 are the same as those described for the spatial and temporal characteristics of EBS and Aleutian Islands pollock under PA.1.

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

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that PA.2 would have an insignificant effect on pollock prey availability.

- **Persistent Past Effects.** Past effects on EBS and Aleutian Islands prey availability are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on EBS and Aleutian Islands prey availability are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under PA.2; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under the PA..2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, as described in the direct/indirect effects section, PA.2 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects**. Past effects identified for EBS and Aleutian Islands habitat suitability are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on EBS and Aleutian Islands habitat suitability are the same as those indicated under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under PA.2; however, their significance on the EBS and Aleutian Islands pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-1 for a summary of the cumulative effects on EBS and Aleutian Islands pollock under PA.2.

GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under PA.2 (see Section 4.9.1.1 direct/indirect effects discussion).

- **Persistent Past Effects**. Past effects identified for GOA pollock mortality are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects**. Future external effects on GOA pollock mortality are the same as those considered under PA.1.

- **Cumulative Effects**. Cumulative effects are identified for mortality of GOA pollock, but the effects are judged to be insignificant under PA.2. Pollock are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under PA.2 (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the GOA change in biomass are identical to those discussed under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on GOA pollock change in biomass are the same as those considered under PA.1.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** For GOA pollock, the stock is expected to be above MSST for the years 2003-2007 (see direct/indirect effects discussion). Therefore, impacts of the spatial and temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of GOA pollock are the same as those described under PA.1.

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

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see the direct/indirect effects discussion). However, it is determined that PA.2 would have an insignificant effect on pollock prey availability.

- **Persistent Past Effects.** Past effects identified for the change in prey availability of GOA pollock are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the change in prey availability of GOA pollock are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under PA.2 and are considered insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that PA.2 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stock are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for the change in habitat suitability of GOA pollock are the same as those considered under PA.1.

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

Refer to Table 4.5-2 for a summary of the cumulative effects on GOA pollock under PA.2.

4.9.1.2 Pacific Cod

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA Pacific cod for each of the bookends under the preferred alternative.

Direct/Indirect Effects of PA.1

<u>Total Biomass</u>

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-44 of Appendix H. Under PA.1, model projections indicate that total BSAI Pacific cod biomass is expected to increase steadily to a value of 2,125,000 mt in 2007, with a 2003-2007 average value of 2,089,000 mt. These values for BSAI Pacific cod total biomass are nearly identical to those predicted under FMP 3.1.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA Pacific cod biomasses are shown in Table H.4-65 of Appendix H. Under PA.1, model projections indicate that total GOA Pacific cod biomass is expected to increase steadily to a value of 675,000 mt in 2007, with a 2003-2007 average value of 622,000 mt. These values for GOA Pacific cod total biomass are nearly identical those predicted under FMP 3.1.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI Pacific cod spawning biomasses are shown in Table H.4-44 of Appendix H. Under PA.1, model projections indicate that BSAI Pacific cod spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 447,300 mt in 2006, then decrease to a value of 445,300 mt in 2007, with a 2003-2007 average value of 431,600 mt. Projected spawning biomass never dips below the B_{MSY} proxy value for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-65 of Appendix H. Under PA.1, model projections indicate that GOA spawning biomass is expected to decrease to a value of 79,100 mt in 2005, then increase to a value of 85,700 mt in 2007, with a 2003-2007 average value of 83,100 mt. Projected spawning biomass never dips below the B_{MSY} proxy value for the years 2003-2007.

Under PA.1, the harvest control rules used to set catch limits will be modified to reduce the TAC, and subsequently the ABC values for BSAI and GOA Pacific cod in an effort to maintain a spawning stock biomass with the potential to produce sustained yields on a continuing basis. The harvest control rules will be modified for GOA pollock and BSAI and GOA Pacific cod under this preferred alternative bookend due to the uncertainty associated with the biomass estimates.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-44 of Appendix H. Under PA.1, model projections indicate that BSAI fishing mortality will increase to a value of 0.284 in 2003, then decrease to a value of 0.266 in 2005, then increase to a value of 0.270 in 2006, then decrease to a value of 0.265 in 2007, with a 2003-2007 average of 0.272. These values are well below the F_{MSY} proxy value (the rate associated with the overfishing level for stocks above $B_{40\%}$).

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-65 of Appendix H. Under PA.1, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.324 in 2003, then decrease to a value of 0.289 in 2005, then increase to a value of 0.312 in 2007, with a 2003-2007 average of 0.304. These values are well below the F_{MSY} proxy value; the rate associated with the overfishing level for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

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

BSAI Pacific cod fisheries may be limited by Pacific halibut PSC limits which are projected to be reduced by 0-10 percent in the BSAI under PA.1.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective overfishing levels in all years under PA.1. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007 (Tables H.4-44 and H.4-65 of Appendix H).

Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI and between 116,000 and 800,000 mt in the GOA. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI Pacific cod under this preferred alternative bookend (same as FMP 1 and FMP 3.1). As mentioned above, the TAC for BSAI and GOA Pacific cod will also be reduced through modification of the harvest control rules due to uncertainty in the biomass estimates. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Age and Size Composition

Under PA.1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.78 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.20 years.

Under PA.1, the projected mean age of the GOA Pacific cod stock in 2008 is 2.75 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.19 years.

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

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative bookend.

Current closure areas would remain under this preferred alternative bookend, including the eastern GOA trawl closure and the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important Pacific cod habitat.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 on Pacific cod would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under this bookend.

A direct fishery for forage fish would continue to be banned under PA.1, and the $B_{20\%}$ rule would remain since Pacific cod (juvenile Pacific cod) is an important prey species for many members of the BSAI and GOA ecosystem.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 on BSAI and GOA Pacific cod.

Cumulative Effects of PA.1 – BSAI Pacific Cod

Mortality

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

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

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

- **Cumulative Effects.** Cumulative effects under PA.1 are identified for mortality of BSAI Pacific cod, but the effects are judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stocks is expected to be insignificant under PA.1 (see the Pacific cod PA.1 direct/indirect effects discussion).

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

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

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under PA.1; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

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

- **Direct/Indirect Effects.** Under PA.1, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

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

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

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration under PA.1; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

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

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

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-3 are determined to be potentially adverse contributors since catch and bycatch of prey species are likely to continue.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, the effect is rated as insignificant (see the direct/indirect effects discussion).

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

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

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

See Table 4.5-3 for a summary of the cumulative effects on BSAI Pacific cod under PA.1.

GOA Pacific Cod

<u>Mortality</u>

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

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

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

- **Cumulative Effects.** A cumulative effect under PA.1 is identified for mortality of GOA Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stocks is expected to be insignificant under the PA.1 (see GOA Pacific cod PA.1 direct/indirect effects discussion).

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

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

- **Cumulative Effects.** A cumulative effect for change in biomass is identified for PA.1; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

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

- **Direct/Indirect Effects.** Under PA.1, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment particularly in the GOA where the state groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to climate changes and regime shifts (see Section 3.5.1.2).

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

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration under PA.1; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

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

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

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

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the PA.1; however, the effects are insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, the effect is rated as insignificant (see the GOA Pacific cod PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod stocks include past foreign, JV, and domestic fisheries, the state crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

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

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under PA.1 and are considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST and the effect is judged insignificant.

See Table 4.5-4 for a summary of the cumulative effects on GOA Pacific cod under PA.1.

Direct/Indirect Effects of PA.2

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-44 of Appendix H. Under PA.2, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,167,000 mt in 2007, with a 2003-2007 average value of 2,113,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-65 of Appendix H. Under PA.2, model projections indicate that total GOA biomass is expected to increase steadily to a value of 688,000 mt in 2007, with a 2003-2007 average value of 631,000 mt. The GOA Pacific cod total biomass values are nearly identical to those projected for FMP 3.2.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-44 of Appendix H. Under PA.2, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,800 mt in 2003, then increase to a value of 461,500 mt in 2007, with a 2003-2007 average value of 440,900 mt. Projected spawning biomass never dips below the B_{MSY} proxy value for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-65 of Appendix H. Under PA.2, model projections indicate that GOA spawning biomass is expected to decrease to a value of 82,400 mt in 2005, then increase to a value of 90,100 mt in 2007, with a 2003-2007 average value of 85,900 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007. The GOA Pacific cod spawning biomass values are nearly identical as those projected for FMP 3.2.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-44 of Appendix H. Under PA.2, model projections indicate that BSAI fishing mortality will increase to a value of 0.268 in 2003, then decrease to a value of 0.245 in 2005, then increase to a value of 0.252 in 2006 and decrease to a value of 0.250 in 2007, with a 2003-2007 average of 0.254. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for stocks above $B_{40\%}$.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-65 of Appendix H. Under PA.2, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.282 in 2003, then decrease to a value of 0.260 in 2005, then increase to a value of 0.281 in 2007, with a 2003-2007 average of 0.271. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Current closures would remain under PA.2, although these closures would be reviewed to see if some areas may qualify as MPAs. Some areas may also be redesignated as gear- or fishery-specific regions. The BSAI and GOA Pacific cod fisheries may be limited by Pacific halibut PSC limits which are projected to be reduced by 0-20 percent in the BSAI and 0-10 percent in the GOA. Inseason bycatch closures will be reevaluated in the BSAI and developed in the GOA, and has the potential to further restrict the Pacific cod fishery from areas where Pacific halibut bycatch is high.

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

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under PA.2. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007 (Tables H.4-44 and H.4-65 of Appendix H).

Under PA.2, OY cap calculations would be revisited to determine their relevancy to current environmental conditions and knowledge of existing stock levels. Procedures to account for the uncertainty in estimating ABC for BSAI and GOA Pacific cod under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. These changes may increase or reduce catch limits for BSAI and GOA Pacific cod in the future. TAC values must be set at levels equal to or less than the ABC for all target species under PA.2.

Age and Size Composition

Under PA.2, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under PA.2, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

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

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under PA.2.

Under PA.2, NPFMC and NOAA Fisheries would consider adopting 0-20 percent of the Bering Sea, Aleutian Islands and GOA as MPAs and no-take reserves across a range of different habitat types (similar to FMP 3.2). Existing closures would be reviewed to see if areas may qualify for MPAs under established criteria. Existing areas may be redefined as gear- or fishery-specific. EFH and HAPC designation would continue under PA.2, as would investigations as to whether fishing has adverse impacts on habitats; mitigation measures would be implemented as necessary. An Aleutian Islands management area would be established under PA.2 to protect coral and live bottom habitats. The 2002 Steller sea lion closures and Aleutian Islands critical habitat designations would be reviewed and modified as is called for by new scientific information. Pollock bottom trawling would be prohibited in the BSAI and GOA under PA.2. Please see the FMP 3.2 maps (Figure 4.2-5) described in Section 4.2 for more information. All of these measures may reduce the adverse impacts of fishing gear on important Pacific cod habitat.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.2 on Pacific cod would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under this FMP. Forage fish commercial fisheries would continue to be banned under PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI and GOA Pacific cod under PA.2.

Cumulative Effects of PA.2 – BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stocks is insignificant under PA.2 (see Section 4.9.1.2 direct/indirect effects discussion).

- **Persistent Past Effects**. Past effects on Pacific cod mortality are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects**. Future external effects on Pacific cod mortality are the same as those described under PA.1.

- **Cumulative Effects**. Cumulative effects under PA.2 are identified for mortality of BSAI Pacific cod, but the effects are judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stocks is expected to be insignificant under PA.2 (see the BSAI Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the BSAI Pacific cod change in biomass are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the BSAI Pacific cod change in biomass are the same as those described under PA.1.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under PA.2; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.2, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific cod population (see the BSAI Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the spatial and temporal characteristics of BSAI Pacific cod are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of BSAI Pacific cod are the same as those indicated under PA.1.

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration under PA.2; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.2 would have insignificant effects on Pacific cod prey availability (see the Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the BSAI Pacific cod change in prey availability are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the BSAI Pacific cod change in prey availability are the same as those described under PA.1.

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

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.2 would have insignificant effects on Pacific cod habitat suitability (see the BSAI Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod habitat suitability are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for BSAI Pacific cod habitat suitability are the same as those indicated under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under the PA.2 and are considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the BSAI Pacific cod stock such that it is unable to sustain itself at or above MSST.

See Table 4.5-3 for a summary of the cumulative effects on BSAI Pacific cod under PA.2.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stocks is insignificant under PA.2 (see the GOA Pacific cod direct/indirect effects section).

- **Persistent Past Effects.** Past effects on GOA Pacific cod mortality are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on GOA Pacific cod mortality are the same as those indicated under PA.1.

- **Cumulative Effects.** A cumulative effect under PA.2 is identified for mortality of GOA Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stocks is expected to be insignificant under PA.2 (see the GOA Pacific cod PA.2 direct/indirect effects section).

- **Persistent Past Effects.** Past effects on the GOA Pacific cod change in biomass are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the GOA Pacific cod change in biomass are the same as those indicated under PA.1.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.2, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the spatial and temporal characteristics of GOA Pacific cod are the identical to those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of GOA Pacific cod are the identical to those described under PA.1.

- **Cumulative Effects**. A cumulative effect is possible for the spatial/temporal concentration under PA.2; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the GOA Pacific cod population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.2 would have insignificant effects on Pacific cod prey availability (see the GOA Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on GOA Pacific cod prey availability are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on GOA Pacific cod prey availability are the same as those indicated under PA.1.

- **Cumulative Effects**. Cumulative effects are identified for prey availability under PA.2; however, they are insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the GOA Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.2 would have insignificant effects on GOA Pacific cod habitat suitability (see the GOA Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects**. Past effects on GOA Pacific cod habitat suitability are the same as those considered under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on GOA Pacific cod habitat suitability are the same as those considered under PA.1.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability under PA.2 and is considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the GOA Pacific cod stock such that it is unable to sustain itself at or above MSST.

See Table 4.5-4 for a summary of the cumulative effects on GOA Pacific cod under PA.2.

4.9.1.3 Sablefish

This section provides the direct, indirect and cumulative effects analysis for sablefish for each of the bookends under the preferred alternative. Sablefish are managed as one stock in the BSAI and GOA; therefore, BSAI and GOA areas are discussed together in this section. For further information regarding persistent past effects listed below in the text and in the table (see Section 3.5.1.3).

Direct/Indirect Effects of PA.1 and PA.2

Catch/ABC

PA.1 is projected to have an insignificant impact on average sablefish yield compared to the baseline. Similar yields are projected because PA.1 assumptions mostly replicate baseline conditions.

PA.2 is projected to significantly decrease sablefish yield compared to the baseline. Similar to FMP 3.2, PA.2 applies a risk-averse adjustment to F_{ABC}. The amount of adjustment is affected by recruitment variability and uncertainty in abundance estimation. Sablefish abundance is estimated with reasonable certainty, but recruitment is highly variable, so that the adjustment is substantial. As a result, projected yield is significantly reduced for PA.2 (Tables H.4-52 and H.4-71 of Appendix H).

Total Biomass

PA.1 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. Total biomass increases from 2002-2007 under PA.1 because long-term average recruitment (1977-present) is used to project biomass and is higher than most recent recruitments (Tables H.4-52 and H.4-71 of Appendix H).

PA.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. Fishing mortality is lower for this alternative compared to baseline, but not enough to significantly increase total biomass (Tables H.4-52 and H.4-71 of Appendix H).

Spawning Biomass

PA.1 is projected to have an insignificant impact on spawning biomass compared to the baseline. PA.1 assumptions mostly replicate baseline conditions. Spawning biomass increases from 2002-2007 under PA.1 because long-term average recruitment (1977-present) is used to project biomass and is higher than recent recruitment (Table H.4-52 of BSAI sablefish and H.4-71 of GOA sablefish found in Appendix H).

PA.2 is projected to have an insignificant impact on spawning biomass compared to the baseline. Fishing mortality is lower for this alternative compared to baseline, but not enough to significantly increase spawning biomass (Table H.4-52 for BSAI sablefish and Table H.4-71 for GOA sablefish found in Appendix H).

Spawning biomass is projected to decrease from 2002-2007 while total biomass is projected to increase during the same interval. Total biomass includes ages 2-30+ while spawning biomass includes ages 6.5-30+ (initial age is average age of first spawning for females) so that spawning biomass trends due to changing recruitment lag total biomass trends. Spawning biomass will likely increase for a longer projection.

Fishing Mortality

Under PA.1 and PA.2, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Tables H.4-52 and H.4-71 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. PA.1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. PA.1 closed areas are the same as baseline. Similarly, existing gear and fishing restrictions would remain under PA.1, including the GOA sablefish pot ban. Sablefish catch limits will continue to be allocated by gear in the BSAI and GOA.

Under PA.2, NPFMC and NOAA Fisheries would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands and GOA as MPAs and no-take reserves across a range of different habitat types (similar to FMP 3.2). Inseason bycatch closures will be reevaluated in the BSAI and developed in the GOA. The proposed closed areas for this alternative may cover some of the areas where the sablefish fishery, both longline and trawl, currently operate, and could thus restrict the fishery to the remaining open areas. Sablefish undergo large migrations (e.g. Heifetz and Fujioka 1991) and substantial genetic mixing is expected for this stock. The degree of spatial and temporal concentration of the fishery is not likely to result in depletion of sub-populations of sablefish if they exist. For this reason, it is not likely that the amount of spatial and temporal concentration of fishing effort would inhibit the stock's ability to remain above the MSST.

Status Determination

Under PA.1, sablefish is not overfished nor approaching an overfished condition. Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI and between 116,000 and 800,000 mt in the GOA. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI sablefish under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Under PA.2, sablefish is not overfished nor approaching an overfished condition. The OY caps would be revisited to determine relevancy to current environmental conditions and our knowledge of current stocks. Procedures to account for the uncertainty in estimating ABC for BSAI and GOA sablefish under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. These changes may increase or reduce catch limits for BSAI and GOA sablefish in the future. TAC values must be set at levels equal to or less than the ABC for all target species under both bookends.

Age and Size Composition

PA.1 and PA.2 are projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

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

Sex Ratio

The sex ratio of the adult population is 40 males:60 females, based on sex ratio data collected during sablefish longline surveys. PA.1 and PA.2 probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

PA.1 would have no significant effect on habitat suitability compared to the baseline because exploitation rates for PA.1 are similar to baseline.

Current closure areas would remain under this preferred alternative bookend, including the eastern GOA trawl closure, the ban on bottom trawling for pollock in the BSAI and the ban on sablefish pot fishing in the GOA. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. These implemented measures may help reduce adverse impacts to important sablefish habitat when overlap occurs.

PA.2 would decrease exploitation rates overall, but could also significantly increase the spatial/temporal concentration of fishing mortality compared to the baseline if sablefish fishery areas are further restricted (similar to FMP 3.2). This could eliminate the local fishing mortality rates on sablefish in the closed areas, but effort also would increase in some areas or times as a result of area closures, thus concentrating the fishery at certain fishing locations and increasing fishing mortality rates on sablefish at these locations. Under PA.2, average catch is projected to decrease by about 1/3 compared to baseline. As long as at least 2/3 of the areas remain open, the remaining catch should not decrease habitat suitability in the open areas and the habitat suitability of closed areas should improve, to the extent that fishing affects habitat suitability.

Existing closures under PA.2 would be reviewed to see if areas may qualify for MPAs under established criteria. Existing areas may be redefined as gear- or fishery-specific. EFH and HAPC designation would continue under PA.2, as would investigations as to whether fishing has adverse impacts on habitats; mitigation measures would be implemented as necessary. An Aleutian Islands management area would be established under PA.2 to protect coral and live bottom habitats. The 2002 Steller sea lion closures and Aleutian Islands critical habitat designations would be reviewed and modified as is called for by new scientific information. Pollock bottom trawling would be prohibited in the BSAI and GOA under PA.2.

Please see the FMP 3.2 map (Figure 4.2-5) described in Section 4.2 for more information. All of these measures may reduce the adverse impacts of fishing gear on important sablefish habitat where overlap occurs.

Predator-Prey Relationships

PA.1 and PA.2 are projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline, so PA.1 and PA.2 should have an insignificant effect on the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish (Table 4.9-1). A directed forage fish fishery would continue to be banned under each of these bookends.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under PA.1 and PA.2 (see the direct/indirect effects discussion).

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

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

- **Cumulative Effects.** Cumulative effects under PA.1 and PA.2 are identified for mortality of sablefish, but the effects are judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under PA.1 and PA.2 (see direct/indirect effects discussion).

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

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

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see the direct/indirect effects discussion).

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

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.1 and PA.2 would have insignificant effects on sablefish prey availability (see the direct/indirect effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on sablefish prey species could be either beneficial or adverse since strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Section 3.5.1.3). Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-5 are determined to be potentially adverse contributors since catch and bycatch of prey species are likely to continue.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. PA.1 is not expected to impact habitat compared to baseline. Therefore, it is determined that PA.1 and PA.2 would have insignificant effects on sablefish habitat suitability (see the direct/indirect effects discussion).

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

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

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

See Table 4.5-5 for a summary of the cumulative effects on BSAI and GOA sablefish under PA.1.

4.9.1.4 Atka Mackerel

This section provides the direct, indirect and cumulative effects analysis for Aleutian Islands and GOA Atka mackerel for each of the bookends under the preferred alternative. For further information regarding persistent past effects listed below in the text and in the tables see Section 3.5.1.4.

External effects and the resultant cumulative effects associated with PA.1 and PA.2 are depicted on Tables 4.5-6 and 4.5-7. For further information regarding persistent past effects listed below in the text and in the tables see Section 3.5.1.4.

Direct/Indirect Effects of PA.1

Model projections of future Aleutian Islands Atka mackerel catch and biomass levels under PA.1 assume the maximum permissible fishing mortality rate according to Amendment 56 ABC/OFL definitions.

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

Catch and Fishing Mortality

The average expected yield for Aleutian Islands Atka mackerel for the period 2003-2007 is 62,700 mt (Table H.4-58 of Appendix H). The catch and ABC values, which are nearly equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the Aleutian Islands Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.436 in 2004, then decrease in 2005 and increase to 0.401 in 2007. Overall, the projections show a 60 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the F_{MSY} proxy ($F_{35\%}$) value of 0.564 which is the rate associated with the OFL.

Projections of GOA Atka mackerel under PA.1 indicate that catches will likely average about 350 mt through 2007 (Table H.4-79 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g. Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

Total Biomass

Total (ages 1-15+) biomass of Aleutian Islands Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total Aleutian Islands total biomasses are shown in Table H.4-58 of Appendix H. Under PA.1, model projections indicate that total Aleutian Islands Atka mackerel is expected to decline to a value of 415,000 mt by 2005, then increase to a value of 442,000 mt by 2007, with a 2003-2007 average value of 435,000 mt. Overall, the projections show an 8 percent decrease in total biomass from 2002 to 2007 under PA.1. These values for Aleutian Islands Atka mackerel total biomass are nearly identical to those projected under FMP 3.1.

Spawning Biomass

Spawning biomass of female Aleutian Islands Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future Aleutian Islands spawning biomasses are shown in Table H.4-58 of Appendix H. Under PA.1, model projections indicate that Aleutian Islands spawning biomass is expected to decline to a value of 78,500 mt by 2005, then increase to a value of 88,000 mt by 2007, with a 2003-2007 average value of 88,900 mt. Overall, the projections show about a 26 percent decrease in female spawning biomass from 2002 to 2007 under PA.1. Projected spawning biomass exceeds the proxy B_{MSY} value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007). These values for Aleutian Islands Atka mackerel spawning biomass are nearly identical to those projected under FMP 3.1.

Spatial/Temporal Concentration of Fishing Mortality

Under PA.1, the current network of spatial and temporal closed areas is in place. The closures designated in the Steller sea lion protection measures probably have the largest impact relative to Atka mackerel. The 2002 Steller sea lion closures implemented under PA.1 include no fishing in Seguam Pass, 3 nm no transit zones around rookeries, and trawl and fixed gear closures in nearshore and Steller sea lion critical habitats.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutian Islands appear to be replenished by immigration and recruitment. In addition, management measures are in place which have the effect of spreading out the harvest in time and space. The overall Aleutian Islands TAC is allocated to three management areas (western, central, and Bering Sea/eastern Aleutians). The regional TACs are further allocated to two seasons and there are limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. The temporal/spatial concentration of the catch under PA.1 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself about its MSST.

Status Determination

Model projections of future catches of Aleutian Islands Atka mackerel are below the OFL in all years under PA.1 (Table H.4-58 of Appendix H). Female spawning biomass in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy), thus the Aleutian Islands Atka mackerel stock is not overfished and is determined to be above its MSST under PA.1.

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

Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI and between 116,000 and 800,000 mt in the GOA. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for Aleutian Islands Atka mackerel under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Age and Size Composition

Under PA.1, the mean age of Aleutian Islands Atka mackerel in 2007, as computed in model projections, is 2.73 years. This compares with a mean age in the equilibrium unfished Aleutian Islands stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term, however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level; therefore, it is unlikely that the age and size compositions would change in the future under PA.1. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than due to the effects of fishing.

Sex Ratio

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

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, Steller sea lion protection measures may provide habitat protection for Atka mackerel through effort limitations and reductions. The level of habitat disturbance caused by the fishery under PA.1 does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Current area closures would remain under PA.1, including the eastern GOA trawl closures. Programs to identify EFH and HAPC would continue and a process for establishing MPAs would be developed.

Predator-Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that PA.1 will not impact prey availability for Aleutian Islands and GOA Atka mackerel. The $B_{20\%}$ rule will remain under PA.1 since Akta mackerel are an important prey species for many members of the Aleutian Islands and GOA ecosystem (same as FMP 1 and FMP 3.1).

See Table 4.9-1 for a summary of the direct/indirect effects on Aleutian Islands and GOA Atka mackerel under PA.1.

Cumulative Effects of PA.1 – Aleutian Islands Atka Mackerel

Mortality

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

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

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

- **Cumulative Effects.** Cumulative effects under PA.1 are identified for mortality of Aleutian Islands Atka mackerel, but the effects are judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the Aleutian Islands Atka mackerel stock is expected to be insignificant under PA.1 (see the Atka mackerel PA.1 direct/indirect effects discussion).

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

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

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

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

- **Direct/Indirect Effects.** The temporal/spatial concentration of the catch under PA.1 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself about its MSST and the effect is judged insignificant (see the Atka mackerel PA.1 direct/indirect effects section above).

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

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

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

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that PA.1 will have an insignificant effect on prey availability for Aleutian Islands Atka mackerel (see the Atka mackerel PA.1 direct/indirect effects discussion).

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

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

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

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Habitat disturbances caused by the fishery under PA.1 do not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST ,and the effect is judged insignificant (see the Atka mackerel PA.1 direct/indirect effects discussion).

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

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

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

See Table 4.5-6 for a summary of cumulative effects on Aleutian Islands Atka mackerel under PA.1.

GOA Atka Mackerel

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under PA.1. The fishing mortality rate and the MSST for GOA Atka mackerel is unknown, thus the effect of fishing mortality is unknown under PA.1.

- **Persistent Past Effects**. Past effects of the past foreign, JV, and domestic, fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, JV, and fisheries, have had a lingering effect on the GOA Atka mackerel population that has not yet recovered (see Section 3.5.1.4).

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

- **Cumulative Effects.** A cumulative effect under PA.1 is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and their MSST is unknown; therefore a status determination cannot be made.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the GOA Atka mackerel stock is unknown PA.1. Current reliable estimates of total and spawning biomass are unknown for GOA Atka mackerel.

- **Persistent Past Effects**. Past effects of the past foreign, JV, and domestic fisheries are identified for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, JV, domestic fisheries and are determined to have had a lingering effect on the GOA Atka mackerel population, which has not yet recovered (see Section 3.5.1.4)

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

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration effects are also unknown under PA.1.

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. The past highly localized fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.4).

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that PA.1 will not impact prey availability for GOA Atka mackerel and the impact to the prey availability effect is determined to be insignificant.

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

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the habitat suitability effects are also unknown under PA.1.

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

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

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, the significance of the effects on the Aleutian Islands Atka mackerel stock are unknown.

See Table 4.5-7 for a summary of the cumulative effects on GOA Atka mackerel under PA.1.

Direct/Indirect Effects of PA.2

Model projections of future Aleutian Islands Atka mackerel catch and biomass levels under PA.2 assume an uncertainty correction applied to the maximum permissible fishing mortality rate according to Amendment 56 ABC/OFL definitions.

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

Catch and Fishing Mortality

The average expected yield for Aleutian Islands Atka mackerel for the period 2003-2007 is 52,390 mt. The catch and ABC values (which are nearly equivalent after 2004) are expected to decrease through 2006. The average fishing mortality imposed on the Aleutian Islands Atka mackerel stock in 2002 is 0.251 (Table H.4-58 of Appendix H). Model projections show this value will increase to 0.309 in 2005, then decrease to 0.304 in 2007. Overall, the projections show a 21 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the F_{MSY} proxy ($F_{35\%}$) value, which is the rate associated with the OFL.

Projections of GOA Atka mackerel under PA.2 indicate that catches will likely average a little over 150 mt through 2007 (Table H.4-79 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g. Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

Total Biomass

Total (ages 1-15+) biomass of Aleutian Islands Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total Aleutian Islands total biomasses are shown in Table H.4-58 of Appendix H. Under PA.2, model projections indicate that total Aleutian Islands Atka mackerel biomass is expected to decline to a value of 451,000 mt by 2004, then increase to a value of 470,000 mt by 2007, with a 2003-2007 average value of 459,000 mt. Overall, the projections show a 2 percent decrease in total biomass from 2002 to 2007 under PA.2. These values for Aleutian Islands Atka mackerel total biomass are nearly identical to those projected for FMP 3.2.

Spawning Biomass

Spawning biomass of female Aleutian Islands Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future Aleutian Islands spawning biomasses are shown in Table H.4-58 of Appendix H. Under PA.2, model projections indicate that Aleutian Islands spawning biomass is expected to decline to a value of 93,500 mt by 2005, then increase to a value of 100,700 mt by 2007, with a 2003-2007 average value of 101,700 mt. Overall, the projections show a 15 percent decrease in spawning biomass from 2002 to 2007 under PA.2. Projected spawning biomass exceeds the B_{MSY} proxy value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007). These values for Aleutian Islands Atka mackerel spawning biomass are nearly identical to those projected for FMP 3.2.

Spatial/Temporal Concentration of Fishing Mortality

Under PA.2, NPFMC and NOAA Fisheries would consider establishing 0-20 percent of the Bering Sea, Aleutian Islands and GOA as MPAs and no-take marine reserves across a range of habitat types (similar to FMP 3.2). The spatial closures illustrated in the FMP 3.2 map (Figure 4.2-5, Section 4.2) in the Aleutian Islands under PA.2 would likely impact the directed fishery for Atka mackerel. Based on locations of historical Atka mackerel fishing effort, some catches of Atka mackerel are likely to be displaced under PA.2, but it is assumed that these catches could be taken (at least in the short-term) in the remaining open areas. As such, the temporal/spatial concentration of the catch will likely increase under PA.2. Because Atka mackerel are a patchily distributed fish and the harvest is concentrated in specific locations, there is an increased risk of localized depletion that may occur under this preferred alternative bookend. However, PA.2 is not likely to adversely affect the sustainability of the stock (at least in the short-term) either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST.

Status Determination

Model projections of future catches of Aleutian Islands Atka mackerel are below the OFL in all years under PA.2 (Table H.4-58 of Appendix H). Estimates of female spawning biomass in each of the projection years (2003-2007), are above $B_{35\%}$ (B_{MSY} proxy), thus the Aleutian Islands Atka mackerel stock is not overfished and is determined to be above its MSST under PA.2.

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

Calculation of the OY caps for the BSAI and GOA would be revisited to determine relevance to current environmental conditions and current stock information. Procedures to account for the uncertainty in estimating ABC for Aleutian Islands and GOA Atka mackerel under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. Programs designed to collect biological information necessary to determine spawning stock biomass estimates would be improved under PA.2, which could affect the catch limits of GOA Atka mackerel, currently a Tier 6 species with no biomass data available. These changes may increase or reduce catch limits for Aleutian Islands and GOA Atka mackerel in the future. TAC values must be set at levels equal to or less than the ABC for all target species under PA.2.

Age and Size Composition

Under PA.2, the mean age of Aleutian Islands Atka mackerel in 2007, as computed in model projections, is 2.85 years. This compares with a mean age in the equilibrium unfished Aleutian Islands stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level; therefore, it is unlikely that the age and size compositions would change in the future under PA.2. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than due to the effects of fishing.

Sex Ratio

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

Habitat Suitability

The spatial closures in the Aleutian Islands under PA.2 could eliminate some Atka mackerel fishery areas while increasing effort in the fewer remaining open areas (similar to FMP 3.2). The level of habitat disturbance would decrease in the closed areas, but increase in the remaining open areas. However, PA.2 is not likely to adversely affect the sustainability of the stock (at least in the short-term) as measured by the ability of the stock to maintain itself above its MSST. The removal of directed fishing in some areas may lead to habitat improvement, but whether this would translate into improved reproductive success is uncertain.

Under PA.2, the 2002 Steller sea lion closures and Aleutian Islands critical habitat designations would be modified as deemed necessary and as new scientific information becomes available. Existing fishery closures would be reviewed to determine if some areas qualify as MPAs; others may be redesignated as fishery- or gear-specific. Programs to identify and designate EFH and HAPC would continue and an Aleutian Islands management area would be established to protect coral and live bottom habitats. All these measures may help protect important Atka mackerel habitat where overlap occurs.

Predator-Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions, which are currently difficult to quantify. Under PA.2, elimination of the directed fishery for Atka mackerel in some areas and increased effort in other areas could impact the amount of Atka mackerel available to the ecosystem. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that PA.2 will not impact prey availability for Aleutian Islands and GOA Atka mackerel. The $B_{20\%}$ rule will remain under PA.2 since Atka mackerel is an important prey species for many members of the Aleutian Islands and GOA ecosystem.

See Table 4.9-1 for a summary of the direct/indirect effects on Aleutian Islands and GOA Atka mackerel under PA.2.

Cumulative Effects of PA.2 – Aleutian Islands Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the Aleutian Islands Atka mackerel stock is insignificant under PA.2 (see the Atka mackerel PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** on Atka mackerel mortality are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on Atka mackerel mortality are the same as those described under PA.1.

- **Cumulative Effects**. A cumulative effect under PA.2 is identified for mortality of Aleutian Islands Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the Aleutian Islands Atka mackerel stock is expected to be insignificant under PA.2 (see the Atka mackerel PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the change in biomass of Atka mackerel are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass of Atka mackerel are the same as those indicated under PA.1.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified. The effect is determined to be insignificant since the combination of internal and external factors is not likely to decrease the Aleutian Islands Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

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

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

- **Direct/Indirect Effects.** PA.2 is not likely to adversely affect the sustainability of the Aleutian Islands stock (at least in the short-term) either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST and the effect is judged to be insignificant (see the Atka mackerel PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the spatial and temporal characteristics of Aleutian Islands Atka mackerel are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of Atka mackerel are the same as those described under PA.1.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; the effect is insignificant for change in the genetic structure of the population because there is no evidence of genetic sub-population structure. The cumulative effect on reproductive success is also judged insignificant.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, the effect is judged insignificant (see the Atka mackerel PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the change in prey availability of Atka mackerel are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of Atka mackerel are the same as those indicated under PA.1.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** The reduction of the fishery under this PA.2 may lead to habitat improvement, but the effect on the stock's ability to maintain itself above its MSST is judged insignificant (see Aleutian Islands Atka mackerel PA. 2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for Aleutian Islands Atka mackerel stocks are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for Aleutian Islands Atka mackerel stocks are the same as those indicated under PA.1.

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

See Table 4.5-6 for a summary of the cumulative effects on Aleutian Islands Atka mackerel under PA.2.

GOA Atka Mackerel

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Therefore, the direct and indirect effects of the PA.2 are unknown for all categories with the exception of prey availability. In addition, the external effects and cumulative effects are the same as those described above for PA.1 in the GOA. Since all of the internal effects on mortality, biomass, spatial/temporal concentration, and habitat are unknown, the cumulative effects on GOA Atka mackerel are also unknown (see Table 4.5-14).

The internal effects of the PA.2 on change in prey availability is judged insignificant because the main prey items for Atka mackerel are invertebrates. However, the cumulative effect for this category is also judged unknown since the direction of the external effects is unknown.

As part of PA.2, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in Tier designation for GOA Atka mackerel. Procedures to account for uncertainty in estimating ABC would be revised and updated as necessary and ecosystem interactions would be considered when determining catch limits. All these measures may affect the TAC, ABC and OFL values of GOA Atka mackerel in the future under PA.2. Although, as stated above, impacts to Atka mackerel mortality and biomass levels are unknown.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. Inseason bycatch closures will be developed in the GOA under PA.2. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. 2002 SSL closures may also be modified as seen necessary under this preferred alternative bookend. These measures may help reduce adverse impacts to GOA Atka mackerel habitat where overlap occurs; although, as stated above, impacts to Atka mackerel habitat suitability are unknown.

4.9.1.5 Yellowfin Sole and Shallow Water Flatfish

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

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

External effects associated with the preferred alternative bookends, PA.1 and PA.2, are depicted on Tables 4.5-8 and 4.5-9 for BSAI yellowfin sole and GOA shallow water flatfish, respectively. For further information regarding persistent past effects listed below in the text and in Tables 4.5-8 and 4.5-9, refer to Section 3.5.1.5.

BSAI Yellowfin Sole – Direct/Indirect Effects of PA.1 and PA.2

<u>Total Biomass</u>

The total biomass of yellowfin sole at the start of 2002 is estimated to be 1,552,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-45 of Appendix H. Under PA.1, model projections indicate that the total BSAI biomass is expected to decline to 1,520,000 in 2007 with a 2003-2007 average total biomass of 1,532,000 mt. Under PA.2, model projections indicate that the total BSAI biomass is expected to decline to 1,519,000 in 2007 with a 2003-2007 average value is 1,532,000 mt.

<u>Spawning Biomass</u>

Spawning biomass of female yellowfin sole at the start of 2002 is estimated to be 450,700 mt. Model projections of future yellowfin sole spawning biomass estimates are shown in Table H.4-45 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to decline to 408,900 mt by 2007, with a 2003-2007 average value of 433,800 mt. Under PA.2, model projections indicate that female spawning biomass is expected to decline to the 2002 value to 408,600 mt by 2007, with a 2003-2007 average value of 434,000 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the five year projection.

<u>Fishing Mortality</u>

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Under PA.1, model projections show this value will steadily increase to 0.099 in 2007. Under PA.2, model projections show this value will increase to 0.101 in 2007 with an average value of 0.084 from 2003-2007. These values are well below the F_{MSY} proxy value of 0.138, the rate associated with the OFL (Table H.4-45 of Appendix H). BSAI yellowfin sole may be limited somewhat by Pacific halibut PSC limits which could undergo a reduction between 0 and 10 percent under PA.1 and between 0 and 20 percent under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space (including high Pacific halibut bycatch areas). Existing closures would be retained under PA.1, including existing inseason bycatch closures. As stated above, BSAI yellowfin sole may be limited temporally by Pacific halibut PSC limits.

As part of PA.1, an IR/IU program would be initiated for BSAI yellowfin sole. The IR/IU program is designed to reduce discard waste of BSAI yellowfin sole by allowing the fishing industry to develop new methods for avoiding unwanted bycatch and/or through the development of new markets for the bycatch. This program was previously initiated by NOAA Fisheries on January 1, 2003 (BSAI FMP Amendment 75), but was suspended on February 7, 2003 due to the need for clarification in the regulation. Discards occur mostly in the directed yellowfin sole fishery, and also occur in the Pacific cod, rock sole, flathead sole and other flatfish fisheries (Wilderbuer and Nichol 2002).

It is unknown what goals, objectives and criteria would be developed under PA.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated then the baseline 2002 fishery. Closure areas under PA.2 are similar to those described under FMP 3.2 and are illustrated in the FMP 3.2 map (Figure 4.2-5) described in Section 4.2.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea, Aleutian Islands and GOA as MPAs and no-take marine reserves across a range of habitats (Figure 4.2-5, FMP 3.2 map). Programs to identify, designate and assess EFH and HAPC would be continue under this preferred alternative bookend. These measures, among others, may help reduce adverse impacts to BSAI yellowfin sole habitat where overlap occurs.

Status Determination

Model projections of future catches of BSAI yellowfin sole are below the OFLs in all years under PA.1 and PA.2. The yellowfin sole stock is above the MSST level in 2002.

Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI yellowfin sole under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Procedures to account for the uncertainty in estimating ABC for BSAI yellowfin sole under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. These changes may increase or reduce catch limits for BSAI yellowfin sole in the future. TAC values must be set at levels equal to or less than the ABC for all target species under PA.2. PA.2 would reconsider OY caps in relation to existing environmental and stock status conditions.

Age and Size Composition

Under PA.1 and PA.2, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-45 of Appendix H), is 6.23 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.04 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of yellowfin sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under PA.1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. These implemented measures may help reduce adverse impacts to important yellowfin sole habitat when overlap occurs.

As stated above, NOAA Fisheries and NPFMC would consider adopting 0 to 20 percent of the Bering Sea as MPAs and no-take marine reserves under PA.2. Existing fishery closures would be reviewed to determine if some areas qualify as MPAs; others may be redesignated as fishery- or gear-specific. Programs to identify and designate EFH and HAPC would also be continued. All these measures may help protect important yellowfin habitat where overlap occurs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on yellowfin sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on EBS yellowfin sole under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the yellowfin sole is rated as insignificant under PA.1 and PA.2 (see the EBS yellowfin sole direct/indirect effects discussion). Under PA.1 and PA.2, the annual fishing mortality values are below the F_{MSY} proxy value of 0.138. Therefore, PA.1 and PA.2 are expected to have insignificant impacts on these stocks.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts are not considered as contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of yellowfin sole.

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

Change in Biomass Level

- **Direct/Indirect Effects.** PA.1 or PA.2 are expected to result in insignificant effects to these stocks (see the BSAI yellowfin sole direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the yellowfin sole stock.

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

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.1and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see the BSAI yellowfin sole direct/indirect effects discussion).

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

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

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

Change in Prey Availability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in prey availability for the yellowfin sole is ranked as insignificant (see the yellowfin sole direct/indirect effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** As described for biomass, effect of the climate changes and regime shifts on the EBS yellowfin sole stock are potentially beneficial or adverse. Marine pollution has also been identified as having a potentially adverse contribution.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the yellowfin sole is ranked as insignificant (see the yellowfin sole direct/indirect effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** As described above, the effects of the climate changes and regime shifts on the yellowfin sole stock are potentially beneficial or adverse.

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

See Table 4.5-8 for a summary of the cumulative effects on yellowfin sole under PA.1 and PA.2.

GOA Shallow Water Flatfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Estimated total and spawning biomass is not available for GOA shallow water flatfish.

Fishing Mortality

The catch of GOA shallow water flatfish in 2002 was estimated to be 6,800 mt. Model projections of future catch are shown in Table H.4-68 of Appendix H. Under PA.1, model projections indicate that the catch is expected to decrease from 5,900 mt in 2003 to 4,900 mt in 2007. The 2003-2007 average value is 5,600 mt. However, the shallow water flatfish fishery is likely to be limited by Pacific halibut PSC limits. Under PA.2, model projections indicate that the catch is expected to decrease to 5,000 in 2007 with a 2003-2007 average of 5,000 mt. GOA shallow water flatfish catch is likely to be limited by Pacific halibut PSC limits, which are projected to be reduced by 0-10 percent under PA.2

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented, and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future changes in Tier designation for GOA shallow water flatfish.

The anticipated low levels of exploitation of GOA shallow water flatfish under PA.1 and PA.2 would have insignificant effects on these stocks through mortality.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA shallow water flatfish harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Existing closures would remain under PA.1, including inseason bycatch closures.

As part of PA.1, an IR/IU program for GOA shallow water flatfish would be implemented. The IR/IU program is designed to reduce discard waste by encouraging the fishing industry to develop methods to avoid high bycatch areas and/or develop markets for the bycatch. This program was previously initiated by NOAA Fisheries on January 1, 2003 (BSAI FMP Amendment 75), but was suspended on February 7, 2003 due to the need for clarification in the regulation. As mentioned above, the shallow water flatfish fishery is likely to be limited temporally due to the attainment of Pacific halibut PSC limits.

Under PA.1, the Observer Program would continue, although training programs designed to increase species identifications would not be included, and station improvements as described under FMP 3.2 would not occur in the immediate future. However, uncertainty estimates would be developed and revised.

The shallow water flatfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-20 percent in the GOA under PA.2. This in combination with the development of inseason bycatch closures (for hotspot areas) could temporally and spatially restrict the fishery. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

Status Determination

The available information for flatfish species in the shallow water complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine their status. Under PA.1 and PA.2, the ABC must be set below the OFL; under PA.1 the sum of the TACs must be within the OY (116,000-800,000 mt for the GOA). Under PA.2, OY caps would be reconsidered in light of their relevancy to current environmental conditions and knowledge of stock levels.

Age and Size Composition

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

Sex Ratio

The sex ratio of shallow water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under PA.1, including the eastern GOA trawl closure. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. These implemented measures may help reduce adverse impacts to important shallow water flatfish habitat when overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may help reduce adverse impacts to GOA shallow water flatfish habitat where overlap occurs, although, as stated above, impacts to shallow water flatfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on shallow water flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on GOA shallow water flatfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under PA.1 and PA.2 (see the direct/indirect effects discussion).

- **Persistent Past Effects**. Past JV and domestic fisheries have been identified as having lingering past negative effects on the GOA shallow water flatfish complex (see Section 3.5.1.5).

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

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

Change in Biomass

- **Direct/Indirect Effects.** Since the total and spawning biomass estimates for GOA shallow water species are unavailable, the effects of PA.1 and PA.2 on change in biomass are unknown (see the GOA shallow water flatfish direct/indirect effects discussion).

- **Persistent Past Effects.** The past JV and domestic fisheries are identified as having past lingering negative effects on the biomass levels of GOA shallow water flatfish (see Section 3.5.1.5).

- **Reasonably Foreseeable Future External Events.** As described above for mortality, effects on biomass are indicated due to the potentially adverse contributions of marine pollution. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse contributions on the shallow water flatfish species biomass level. However, the State of Alaska scallop fishery is not considered to be contributing factor since bycatch of shallow water flatfish species is not expected to occur in this fishery.

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

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

- **Direct/Indirect Effects.** It is unknown how the spatial and temporal distribution of the annual GOA shallow water flatfish harvest will be affected under PA.1 and PA.2 relative to the 2002 baseline year.

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

- **Reasonably Foreseeable Future External Effects**. Future external effects on the reproductive success of shallow water flatfish species due to climate changes and regime shifts are potentially beneficial or adverse as described for mortality. Marine pollution has been identified as having a potentially adverse contribution, and the State of Alaska scallop fishery is not a contributing factor.

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

Change in Prey Availability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in prey availability for GOA shallow water flatfish is determined to be unknown (see the GOA shallow water flatfish direct/indirect effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse as described above for mortality. Marine pollution has also been identified as having a potentially adverse contribution, and the State of Alaska scallop fishery is not considered to be a contributing factor.

- **Cumulative Effects.** Cumulative effects for change in prey availability are unknown. The predation-mediated impacts of PA.1 and PA.2 on shallow water flatfish are governed by a complex web of indirect interactions which are currently difficult to quantify.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be unknown (see the GOA shallow water flatfish direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for GOA shallow water flatfish include climate changes and regime shifts as described for prey availability. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Sections 3.5.1.5 and 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse as discussed above for mortality. Marine pollution has also been identified as having a potentially adverse contribution. The State of Alaska scallop fishery is also identified as a potential adverse contributor to GOA shallow water flatfish habitat suitability. See Section 3.6 for information of the impacts of fishery gear on EFH.

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

See Table 4.5-9 for a summary of the cumulative effects on GOA shallow water flatfish under PA.1 and PA.2.

4.9.1.6 Rock Sole

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

Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of rock sole at the start of 2002 is estimated to be 970,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-48 of Appendix H. Under PA.1, model projections indicate that the total BSAI biomass is expected to decline to 710,000 mt by 2007 with a 2003-2007 average total biomass of 779,000 mt. Under PA.2, model projections indicate that the total BSAI biomass is expected to decline to 690,000 in 2007, with a 2003-2007 average value of 771,000 mt.

Spawning Biomass

Spawning biomass of female rock sole at the start of 2002 is estimated to be 331,000 mt. Model projections of future rock sole spawning biomass estimates are shown in Table H.4-48 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to decline to 189,000 mt by 2007, with a 2003-2007 average value of 244,500 mt. Under PA.2, model projections indicate that female spawning biomass is expected to decline to 180,400 mt by 2007, with a 2003-2007 average value of 240,700 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.055. Under PA.1, model projections show this value will steadily increase to 0.104 in 2007. Under PA.2, model projections show this value will steadily increase to 0.126 by 2007. These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL (Table H.4-48 of Appendix H). Catch rates of BSAI rock sole may be limited by Pacific halibut PSC limits, which could be reduced by 0-10 percent in the BSAI under PA.1 and by 0-20 percent in the BSAI under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI rock sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this preferred alternative bookend or what the effect of hot-spot management of PSC would have on fishing behavior. As stated above, the rock sole fishery may also be limited temporally by Pacific halibut PSC limits.

As part of PA.1, an IR/IU program would be initiated for BSAI rock sole. The IR/IU program is designed to reduce discard waste of BSAI rock sole by allowing the fishing industry to develop new methods for avoiding unwanted bycatch and/or through the development of new markets for the bycatch. This program was previously initiated by NOAA Fisheries on January 1, 2003 (BSAI FMP Amendment 75), but was suspended on February 7, 2003 due to the need for clarification in the regulation. Discards occur mostly in the directed rock sole fishery, yellowfin sole, flathead sole, Pacific cod, and bottom pollock fisheries (Wilderbuer and Walters 2002).

It is unknown what goals, objectives and criteria would be developed under this preferred alternative bookend to allocate TAC in space and time. Existing closure areas would remain and will be reviewed under PA.2 to see if these areas qualify for MPAs or can be redesignated as fishery- or gear-specific areas. NOAA Fisheries and NPFMC would also consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands as MPAs. These area closures are similar to those discussed under FMP 3.2 and are illustrated in the FMP 3.2 map (Figure 4.2-5) in Section 4.2.

Status Determination

Model projections of future catches of BSAI rock sole are below the OFLs in all years under PA.1 and PA.2, and the female spawning stock size is below the MSST. The rock sole stock is above the MSST level in 2002.

Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI rock sole under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Similar to PA.1, under PA.2 the ABC must be set below the OFL values, but OY caps would be revisited to determine relevancy to current environmental conditions and knowledge of stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Age and Size Composition

Under PA.1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections is 4.82 years (Table H.4-48 of Appendix H). Under PA.2, the mean age of the BSAI rock sole stock in 2008, as computed in model projections is 4.74 years (Table H.4-48 of Appendix H). This compares with a mean age in the equilibrium unfished BSAI stock of 5.90 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of rock sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important rock sole habitat where overlap occurs.

As stated above, under PA.2 NPFMC and NOAA Fisheries would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands as MPAs and no-take reserves across a range of different habitat types (similar to FMP 3.2). Existing closures would be reviewed to see if areas may qualify for MPAs under established criteria. Existing areas may be redefined as gear- or fishery-specific. EFH and HAPC designation would continue under PA.2, as would investigations as to whether fishing has adverse impacts on habitats; mitigation measures would be implemented as necessary. An Aleutian Islands management area would be established under PA.2 to protect coral and live bottom habitats. Pollock bottom trawling would be prohibited in the BSAI under PA.2. See the FMP 3.2 maps (Figure 4.2-5) described in Section 4.2 for more information. All of these measures may reduce the adverse impacts of fishing gear on important rock sole habitat where overlap occurs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on rock sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. A directed fishery for forage fish would continue to be banned under PA.1 and PA.2.

See Table 4.9-1 for a summary of the BSAI rock sole direct/indirect effects under PA.1 and PA.2.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under PA.1 and PA.2.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts are not contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rock sole.

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

Change in Biomass Level

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

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

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

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

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

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

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

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

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

Change in Prey Availability

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

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

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

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

Change in Habitat Suitability

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

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

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

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

See Table 4.5-10 for a summary of the cumulative effects on BSAI rock sole under PA.1 and PA.2.

4.9.1.7 Flathead Sole

Flathead sole are described in more detail in Section 3.5.1.7 of this Programmatic SEIS. Flathead sole is managed as its own stock under the BSAI Groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2002, flathead sole were managed independent of the other flatfish complex in the GOA. Until recently, GOA flathead sole were evaluated under Tier 4; beginning in 2004 they will be managed under Tier 3. However, for the purposes of this analysis, flathead sole have been modeled as a Tier 4 species.

BSAI Flathead Sole – Direct/Indirect Effects of PA.1 and PA.2

<u>Total Biomass</u>

Total biomass of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-49 of Appendix H. Under PA.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 492,000 mt in 2006, then increase to 496,000 mt in 2007, with a 2003-2007 average value of 498,000 mt. Under PA.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 491,000 mt in 2006, then increase to 495,000 mt in 2007, with an average of 498,000 mt from 2003-2007.

<u>Spawning Biomass</u>

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 231,200 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-49 of Appendix H. Under PA.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 176,200 mt in 2007, with a 2003-2007 average value of 203,100 mt. Under PA.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 175,200 mt in 2007, with a 2003-2007 average value of 202,900 mt.

<u>Fishing Mortality</u>

Under PA.1, the projected fishing mortality imposed on the BSAI flathead sole stock is 0.053 in 2003, increasing to 0.061 in 2007, with an average from 2003-2007 of 0.052. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 78 percent in 2003 and decreases to 76 percent in 2007, with an average of 79 percent from 2003-2007 (Table H.4-49 of Appendix H). The flathead sole fishery is likely to be limited by Pacific halibut PSC limits which are projected to be reduced by 0-10 percent in the BSAI under PA.1.

Under PA.2, the projected fishing mortality imposed on the BSAI flathead sole stock is approximately 0.053 in 2003, increasing to 0.067 in 2007. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 81 percent in 2003 and decreases to 74 percent in 2007, with an average of 78 percent from 2003-2007 (Table H.4-49 of Appendix H). The BSAI flathead sole fishery will likely be limited by the Pacific halibut PSC limits which are projected to decline between 0-20 percent in the BSAI under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

Under PA.1, a projected average of 11,220 mt of BSAI flathead sole are caught annually from 2003 to 2007, the largest percentage of catch occurring in the EBS shelf Pacific cod fishery, followed closely by the walleye pollock fishery, and yellowfin sole fishery. The directed flathead sole fishery contributes only about 10 percent.

Under PA.1, existing closure areas would remain, including inseason bycatch hotspot closures. As stated above, the flathead sole fishery is likely to be limited temporally by Pacific halibut PSC limits.

The average annual projected harvest of flathead sole under PA.2 was 11,700 mt, of which the yellowfin sole fishery made the largest percentage, followed closely by Pacific cod, and walleye pollock. The directed flathead sole fishery contributes to only about 10 percent of the annual harvest.

Under PA.2, existing closures would remain and would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. As mentioned above, the flathead sole fishery may also be limited temporally due to reaching Pacific halibut PSC limits, or spatially, when avoiding bycatch hotspot areas.

Status Determination

Under PA.1 and PA.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI flathead sole are below ABC and OFL levels from 2003 to 2008.

Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI flathead sole under this preferred alternative. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative and may affect catch limits in the future, as well. Under PA.2 the OY calculation would be re-evaluated to determine relevancy to current environmental conditions and knowledge of stock levels. Also, under PA.2, NOAA Fisheries would develop, implement and update procedures to account for uncertainty in estimating ABC, and species-specific production patterns, as necessary.

Age and Size Composition

Under PA.1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-49 of Appendix H), is 4.57 years. Under PA.2, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-49 of Appendix H), is 4.56 years. This compares with a mean age in the equilibrium unfished stock of 5.39 years.

Sex Ratio

The sex ratio of BSAI flathead sole is assumed to be 50:50. No information is available to suggest that this would change under PA.1 and PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this PA.1 or PA.2.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important flathead sole habitat where overlap occurs.

As mentioned above, the existing closures would remain under PA.2, including the BSAI pollock bottom trawling ban. These closures would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. Existing inseason bycatch closures (e.g., Pacific halibut hotspot areas) would be evaluated for effectiveness and modified as necessary.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2. Directed forage fisheries would continue to be banned under this preferred alternative.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI flathead sole under PA.1 and PA.2.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under PA.1 and PA.2.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole.

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

Change in Biomass Level

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

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

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

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

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

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI flathead sole is ranked as insignificant.

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

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for BSAI flathead sole is ranked as insignificant.

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

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

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

See Table 4.5-11 for a summary of the cumulative effects on BSAI flathead sole under PA.1 and PA.2.

GOA Flathead Sole – Direct/Indirect Effects of PA.1 and PA.2

<u>Total and Spawning Biomass</u>

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

<u>Fishing Mortality</u>

The catch of GOA flathead sole in 2002 was estimated to be 2,000 mt. Model projections of future catch are shown in Table H.4-69 of Appendix H. Under PA.1, model projections indicate that the catch is expected to decrease to 1,500 mt in 2004-2007. The 2003-2007 average value is also 1,570 mt. Under PA.2, model projections indicate that the catch is expected to decrease to 1,500 mt in 2003-2007, with a 2003-2007 average value of 1,500 mt.

<u>Spatial/Temporal Concentration of Fishing Mortality</u>

It is unknown what spatial/temporal characteristics of the annual GOA flathead sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this preferred alternative bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Current closures would remain under PA.1, including the eastern GOA pollock bottom trawl closure.

Flathead sole catch may be limited in the GOA due to Pacific halibut PSC limits which are projected to be reduced by 0-20 percent under PA.2. This, in combination with the development of inseason bycatch closures could actually spatially and temporally restrict the fishery (see FMP 3.2 map [Figure 4.2-5] described in Section 4.2); however, the effects are unknown. Procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA flathead sole.

Status Determination

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

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 116,000 and 800,000 mt in the GOA (same as FMP 1 and FMP 3.1). However, under PA.2, OY cap calculations would be revisited for relevancy with current environmental conditions and stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future.

Age and Size Composition

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

Sex Ratio

The sex ratio of flathead sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1 and PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

As mentioned above, current closure areas would remain under this PA.1, including the ban on bottom trawling for pollock in the eastern GOA as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important flathead sole habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue, and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to GOA flathead sole habitat where overlap occurs, although, as stated above, impacts to flathead sole habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on flathead sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. Directed forage fisheries would continue to be banned under this preferred alternative.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA flathead sole.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Removals by these fisheries have had a lingering negative effect on GOA flathead sole (see Section 3.5.1.7).

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

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

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in biomass level is rated as unknown since MSST is unable to be determined at this time.

- **Persistent Past Effects**. Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Large removals of flathead sole by these fisheries is determined to have had a lingering effect on the GOA flathead sole stock (see Section 3.5.1.7).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the flathead sole biomass level. For more information on climate changes and regime shifts see Section 3.5.1.7 and 3.10. The State of Alaska scallop fishery is identified as a non-contributing factor for change in biomass level since flathead sole bycatch is not expected to occur in this fishery.

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

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

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA flathead sole stock. However, climate changes and regime shifts have been identified as having a positive or negative effect on GOA flathead sole reproductive success. See Section 3.5.1.7 for more information on the effects of climate changes and regime shifts.

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

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch; however, this effect is unknown. The spatial and temporal distribution of flathead sole catch is not expected to change significantly, while it is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA flathead sole stock and include climate changes and regime shifts. For more information on the effects of climate changes and regime shifts on the GOA flathead sole stock (see Section 3.5.1.7).

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

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

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA flathead sole is unknown.

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

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

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

See Table 4.5-12 for a summary of the cumulative effects on GOA flathead sole under PA.1 and PA.2.

4.9.1.8 Arrowtooth Flounder

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

BSAI Arrowtooth Flounder – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-47 of Appendix H. Under PA.1, model projections indicate that the total BSAI biomass is expected to decline to 598,000 mt by 2007, with a 2003-2007 average total biomass of 675,000 mt. Under PA.2, model projections indicate that the total BSAI biomass is expected to decline to 605,000 mt in 2007, with a 2003-2007 average value of 679,000 mt.

Spawning Biomass

Spawning biomass of female BSAI arrowtooth flounder at the start of 2002 is estimated to be 475,900 mt. Model projections of future BSAI arrowtooth flounder spawning biomass estimates are shown in Table H.4-47 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to decline 30 percent of the 2002 value to 330,000 mt by 2007, with a 2003-2007 average value of 388,100 mt. Under PA.2, model projections indicate that female spawning biomass is expected to decline 30 percent of the 2002 value to 334,600 mt by 2007, with a 2003-2007 average value of 390,800 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 182,900 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015. Under PA.1, model projections show this value will steadily increase to 0.024 in 2007. Under PA.2, model projections show this value will slowly increase to 0.020 by 2007. These values are well below the F_{MSY} proxy value of 0.38, the rate associated with the OFL (Table H.4-47 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this preferred alternative bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Current closure areas would remain under PA.1.

It is unknown what goals, objectives and criteria would be developed under PA.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated than the baseline 2002 fishery. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. These closure examples are illustrated in FMP 3.2 map (Figure 4.2-5) discussed in Section 4.2.

Status Determination

Model projections of future catches of BSAI arrowtooth flounder are below the OFLs in all years under PA.1 and PA.2. The arrowtooth flounder stocks are above the MSST level throughout the five year projection, as in the 2002 baseline year.

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI arrowtooth flounder under this preferred alternative bookend (same as FMP 1 and FMP 3.1). However, under PA.2, calculation of OY caps would be reanalyzed in light of current environmental conditions and knowledge of stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well. Under PA.2, NOAA Fisheries would also develop, implement and update procedures to account for uncertainty in estimating ABC, and species-specific production patterns, as necessary.

Age and Size Composition

Under PA.1 and PA.2, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections is 4.81 years (Table H.4-47 of Appendix H). This compares with a mean age in the equilibrium unfished BSAI stock of 5.43 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the BSAI have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important arrowtooth flounder habitat where overlap occurs.

As mentioned above, the existing closures would remain under PA.2, including the BSAI pollock bottom trawling ban. These closures would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the

Bering Sea and Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. Existing inseason bycatch closures (e.g., Pacific halibut hotspot areas) would be evaluated for effectiveness and modified as necessary.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on BSAI arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. A directed fishery for forage fish would continue to be banned under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on BSAI arrowtooth flounder.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of PA.1 and PA.2 on fishing mortality of BSAI arrowtooth flounder is rated as insignificant.

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

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

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

Change in Biomass Level

- **Direct/Indirect Effects.** The effect of PA.1 and PA.2 on the change in biomass of BSAI arrowtooth flounder is insignificant (see the direct/indirect effects section above).

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

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

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

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

- **Direct/Indirect Effects.** The effect of the PA.1 and PA.2 on the spatial/temporal concentration of catch is considered insignificant for the stock.

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

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI arrowtooth flounder is ranked as insignificant.

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

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI arrowtooth flounder is ranked as insignificant.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Neither the IPHC longline fishery nor the State of Alaska herring fishery are considered to be contributing factors to BSAI arrowtooth flounder habitat suitability. The impacts from the fishery gear is expected to be minimal.

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

See Table 4.5-13 for a summary of the cumulative effects on BSAI arrowtooth flounder under PA.1 and PA.2.

GOA Arrowtooth Flounder – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of GOA arrowtooth flounder at the start of 2002 is estimated to be 1,816,000 mt. Model projections of future total GOA biomass estimates are shown in Table H.4-70 of Appendix H. Under PA.1, model projections indicate that the total GOA biomass is expected to increase to 2,082,000 mt by 2007, an abundance level 15 percent more than the 2002 value. The 2003-2007 average total biomass is 1,980,000 mt. Under PA.2, model projections indicate that the total GOA biomass is expected to increase to 2,094,000 in 2007, with a 2003-2007 average value of 1,986,000 mt.

Spawning Biomass

Spawning biomass of female GOA arrowtooth flounder at the start of 2002 is estimated to be 1,113,800 mt. Model projections of future GOA arrowtooth flounder spawning biomass estimates are shown in Table H.4-70 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to increase to 1,152,800 mt by 2007, with a 2003-2007 average value of 1,140,900 mt. Under PA.2, model projections indicate that female spawning biomass is expected to increase 4 percent of the 2002 value to 1,161,600 mt by 2007, with a 2003-2007 average value of 1,145,700 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017. Under PA.1, model projections show this value will be 0.010 in 2007, with a 2003-2007 average of 0.010. Under PA.2, model projections show this value will be 0.009 the first year of the projection and 0.008 in the remaining years until 2007. These values are well below the F_{MSY} proxy value of 0.165, the rate associated with the OFL (Table H.4-70 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Existing closures would remain under this preferred alternative bookend, including the eastern GOA pollock bottom trawling closure.

It is unknown what goals, objectives and criteria would be developed under PA.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated than the baseline 2002 fishery. NOAA Fisheries and NPFMC will consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. This would be similar to closures illustrated under FMP 3.2 map (Figure 4.2-5) described in Section 4.2.

Status Determination

Model projections of future catches of GOA arrowtooth flounder are below the OFLs in all years under PA.1 and PA.2. The arrowtooth flounder stocks are above the MSST level throughout the five year projection, as in the 2002 baseline year.

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 116,000 and 800,000 mt for the GOA. However, under PA.2, OY cap calculations would be revisited for relevancy with current environmental conditions and knowledge of current stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future.

Age and Size Composition

Under PA.1, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-70 of Appendix H), is 5.02 years. Under PA.2, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-70 of Appendix H), is 5.03 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.11 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the GOA have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under PA.1 (described under FMP 1). Definitions and methodology for establishing MPAs would be developed and inseason bycatch closures would be established. These measures may help reduce adverse impacts to important flathead sole habitat where overlap occurs.

As stated above, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. Inseason bycatch closures would also be developed in the GOA under PA.2. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may help reduce adverse impacts to GOA flathead sole habitat where overlap occurs, although, as stated above, impacts to flathead sole habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on GOA arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. A directed forage fish fishery would continue to be banned under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA arrowtooth flounder.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of PA.1 and PA.2 on fishing mortality of the GOA arrowtooth flounder is rated as insignificant.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI arrowtooth flounder under PA.1 and PA.2.

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

Change in Biomass Level

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

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI arrowtooth flounder under PA.1 and PA.2.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure and reproductive success of GOA arrowtooth flounder.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under PA.1 and PA.2.

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

Change in Prey Availability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in prey availability for the GOA arrowtooth flounder is rated as insignificant.

- **Persistent Past Effects.** Past effects identified include climate changes and regime shifts (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey availability are the same as those described for BSAI arrowtooth flounder under PA.1 and PA.2.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for habitat suitability of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on habitat suitability are the same as those described for BSAI arrowtooth flounder under PA.1.

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

See Table 4.5-14 for a summary of the cumulative effects on GOA arrowtooth flounder under PA.1 and PA.2.

4.9.1.9 Greenland Turbot and Deep Water Flatfish

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

BSAI Greenland Turbot – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-46 of Appendix H. Under PA.1, model projections indicate that the total BSAI biomass is expected to decline to 86,000 mt by 2007, an abundance level 19 percent less than the 2002 value. The 2003-2007 average total biomass is 92,000 mt. Under PA.2, model projections indicate that the total BSAI biomass is expected to decline to 90,000 in 2007. The 2003-2007 average value is 94,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-46 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to decline 31 percent of the 2002 value to 46,800 mt by 2007, with a 2003-2007 average value of 54,100 mt. Under PA.2, model projections indicate that female spawning biomass is expected to decline to 50,500 mt by 2007, with a 2003-2007 average value of 56,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,600 mt from 2003-2006 and then drop below this level in 2007.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Under PA.1, model projections show this value will increase to 0.190 in 2004 before decreasing to 0.162 in 2007. Under PA.2, model projections indicate this value will steadily increase to 0.150 by 2007. These values are well below the F_{MSY} proxy value of 0.48, the rate associated with the OFL (Table H.4-46 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Existing closures would remain under PA.1. The Greenland turbot fishery may be limited by Pacific halibut PSC limits which are projected to undergo a reduction of 0-10 percent under PA.1.

It is unknown what goals, objectives and criteria would be developed under PA.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated thaN the baseline 2002 fishery. Existing closure areas would remain and inseason bycatch closures would be evaluated for effectiveness. See FMP 3.2 map (Figure 4.2-5) for a illustration of closures which are similar to those proposed under PA.2. A description of this map can be found in Section 4.2.

Status Determination

Model projections of future catches of BSAI Greenland turbot are below the OFL in all years under PA.1 and PA.2. The Greenland turbot female spawning stock is above the MSST level in all 5 years of the projection, as in the baseline year 2002.

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI Greenland turbot under this preferred alternative (same as FMP 1 and FMP 3.1). Under PA.2, OY caps would be reanalyzed in light of existing environmental conditions and availability of stock status information. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative and may affect catch limits in the future, as well. Under PA.2, procedures to account for uncertainty in estimating ABC and species-specific patterns would be developed, implemented and updated, as necessary.

Age and Size Composition

Under PA.1, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-46 of Appendix H), is 4.56 years. Under PA.2, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-46 of Appendix H), is 4.62 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.93 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under PA.1 and PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important Greenland turbot habitat where overlap occurs.

The existing closures would remain under PA.2, including the BSAI pollock bottom trawling ban. These closures would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. Existing inseason bycatch closures (e.g., Pacific halibut hotspot areas) would be evaluated for effectiveness and modified as necessary.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on Greenland turbot would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 and PA.2. Directed fisheries for forage fish will continue to be banned under this preferred alternative.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on BSAI Greenland turbot.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under PA.1 and PA.2.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts are not considered contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of Greenland turbot.

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

Change in Biomass Level

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

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

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

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the female spawning biomass is above the B_{MSY} value from 2003-2006. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

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

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

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

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

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

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

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

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

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

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

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

See Table 4.5-15 for a summary of the cumulative effects on BSAI Greenland turbot under PA.1 and PA.2.

GOA Deep Water Flatfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

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

Fishing Mortality

The catch of GOA deep water flatfish in 2002 was estimated to be 100 mt. Model projections of future catch are shown in Table H.4-66 of Appendix H. Under PA.1, model projections indicate that the catch is expected to increase to 1,250 mt in 2003, and decrease down to 1,091 mt by 2007, with a 2003-2007 average value of 1,139 mt. Under PA.2, model projections increase to 967 mt by 2007, with a 2003-2007 average value of 899 mt.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future changes in Tier designation for GOA deep water flatfish.

Given the low level of exploitation under these preferred alternative bookends, the effect of PA.1 and PA.2 on GOA deep water flatfish is insignificant through mortality.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA deep water flatfish harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this preferred alternative bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Existing closures would remain under PA.1.

The shallow water flatfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-20 percent in the GOA under PA.2. This, in combination with the development of inseason bycatch closures (for hotspot areas), could temporally and spatially restrict the fishery. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

Status Determination

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

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 116,000 and 800,000 mt in the GOA. However, under PA.2, OY caps would be recalculated in light of existing environmental conditions and knowledge of stock status. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future.

Age and Size Composition

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

Sex Ratio

The sex ratio of deep water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the eastern GOA as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important deep water flatfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may help reduce adverse impacts to GOA shallow water flatfish habitat where overlap occurs, although, as stated above, impacts to shallow water flatfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on deep water flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA deep water flatfish.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deep water flatfish is rated as insignificant under PA.1 and PA.2.

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

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

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

Change in Biomass Level

- **Direct/Indirect Effects.** Total and spawning biomass estimates are unavailable for the deep water flatfish species, therefore, the effects of PA.1 and PA.2 on the change in biomass level are unknown.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause deep water flatfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the deep water flatfish species biomass level. For more information on climate changes and regime shifts, please see Sections 3.5.1.9 and 3.10. The State of Alaska scallop fishery has not been considered as a contributing factor for change in biomass level since deep water flatfish species bycatch is not expected to occur.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown for the stock since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts which are suspected of having an effect on the reproductive success of the deep water flatfish stock complex. See Section 3.5.1.9 for more information on the effects of climate changes and regime shifts.

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the GOA deep water flatfish complex is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA deep water flatfish stock complex and include climate changes and regime shifts (see Section 3.5.1.9).

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA deep water flatfish complex is unknown.

- **Persistent Past Effects.** Past effects identified for GOA deep water flatfish include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of deep water flatfish, largely through the impacts of fishing gear on benthic habitats. See Section 3.5.1.9 for more information on the persistent past effects on deep water flatfish.

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

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

See Table 4.5-16 for a summary of the cumulative effects on GOA deep water flatfish under PA.1 and PA.2.

4.9.1.10 Alaska Plaice, Other Flatfish and Rex Sole

BSAI Alaska plaice and other flatfish and GOA rex sole are described in more detail in Section 3.5.1.10 of this Programmatic SEIS.

BSAI Alaska Plaice – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 1,083,000 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-50 of Appendix H. Under PA.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,117,000 mt in 2007, with a 2003-2007 average value of 1,100,000 mt. Under PA.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,118,000 mt in 2007, with a 2003-2007 average value of 1,101,000 mt.

Spawning Biomass

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 276,900 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-50 of Appendix H. Under

PA.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 281,500 mt in 2007, with a 2003-2007 average value of 278,100 mt. Under PA.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 282,100 mt in 2007, with a 2003-2007 average value of 278,500 mt.

Fishing Mortality

Under PA.1, the projected fishing mortality imposed on the BSAI Alaska plaice stock is 0.017 in 2003, decreasing to 0.016 in 2004, and increasing to 0.020 in 2007, with an average from 2003-2007 of 0.018. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 92 percent in 2003 and decreases to 91 percent in 2007, with an average of 92 percent from 2003-2007 (Table H.4-50 of Appendix H).

Under PA.2, the projected fishing mortality imposed on the BSAI Alaska plaice stock is approximately 0.016 in 2003, increasing to 0.019 in 2007. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 93 percent in 2003 and declines to 91 percent in 2007, with an average of 92 percent from 2003-2007 (Table H.4-50 of Appendix H). The BSAI Alaska plaice fishery may be restricted by Pacific halibut PSC limits, which are projected to decline from 0-20 percent under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

Under PA.1, a projected average of 10,040 mt of BSAI Alaska plaice are caught annually from 2003 to 2007, with the largest percentage (~73 percent) of the harvest occurring in the EBS shelf yellowfin sole fishery. The BSAI Alaska plaice fishery may be limited by Pacific halibut PSC limits, which are expected to be reduced by 0-10 percent under PA.1. Existing closure areas will remain under this preferred alternative bookend, including inseason bycatch closures.

The average annual projected harvest of Alaska plaice under PA.2 was 9,600 mt, with a majority of the harvest occurring in the EBS shelf yellowfin sole fishery. Due to the reduction in PSC limits, and proposed closures under PA.2, it is likely that the Alaska plaice fishery will become more restricted temporally and spatially (see FMP 3.2 map [Figure 4.2-5]) described in Section 4.2 for an illustration of these example closures.

Status Determination

Under PA.1 and PA.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below ABC and OFL levels from 2003 to 2008. Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI Alaska plaice under this preferred alternative bookend (same as FMP 1 and FMP 3.1). However, under PA.2, calculations of OY caps would be revisited for relevancy under existing environmental conditions and knowledge of current stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well. Under PA.2, procedures to account for uncertainty in ABC and species-specific production patterns would be developed, implemented and updated as necessary. These measures could affect the future catch limits of BSAI Alaska plaice in the future.

Age and Size Composition

Under PA.1 and PA.2, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections (Table H.4-50 of Appendix H), is 4.40 years. This compares with a mean age in the equilibrium unfished stock of 4.51 years.

Sex Ratio

The sex ratio of BSAI Alaska plaice is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.1 or PA.2.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important Alaska plaice habitat where overlap occurs.

The existing closures would remain under PA.2, including the BSAI pollock bottom trawling ban. These closures would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. Existing inseason bycatch closures (e.g., Pacific halibut hotspot areas) would be evaluated for effectiveness and modified as necessary.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2. A ban on a directed forage fishery would continue under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI Alaska plaice under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects**. The effect of fishing mortality on the BSAI Alaska plaice stock is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potentially adverse contributor to mortality of BSAI Alaska plaice. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered to be contributors to mortality since a change is not expected to be significant in magnitude sufficient to cause mortality.

- **Cumulative Effects.** Under PA.1 and PA.2, a cumulative effect is identified for BSAI Alaska plaice mortality, and is considered insignificant. Alaska plaice are fished above the ABC and OFL values. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Alaska plaice stock is expected to be insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution events are identified as potentially adverse contributors to BSAI Alaska plaice change in biomass level. Acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are identified as potentially beneficial or adverse contributors to change in biomass level, since recruitment is affected by climate changes and regime shifts through a combination of prey availability and habitat suitability effects.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Alaska plaice change in biomass, and it is rated as insignificant. The combination of internal and external factors are not expected to reduce Alaska plaice biomass such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

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

- **Direct/Indirect Effects.** PA.1 and PA.2 would have an insignificant effect on BSAI Alaska plaice spatial and temporal characteristics.

- **Persistent Past Effects.** No persistent past effects have been identified for the genetic structure of the BSAI Alaska plaice population. Although, climate changes and regime shifts have been identified as having a potentially positive or negative effect on BSAI Alaska plaice reproductive success. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment tends to be favored.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contribution to BSAI Alaska plaice genetic structure and reproductive success. Acute and/or chronic events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and could also result in reduced recruitment. Climate changes and regime shifts have been identified as potentially beneficial or adverse contributors to the reproductive success of BSAI Alaska plaice, but are not contributing factors to the genetic structure of Alaska plaice. The reproductive success is affected through a combination of climate induced changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect has been identified for the spatial and temporal concentration of BSAI Alaska plaice, and is rated as insignificant. The combined internal and external events are not expected to significantly alter the reproductive success or genetic structure such that it jeopardizes the capacity of the stock to maintain itself above MSST.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** PA.1 and PA.2 would have an insignificant effect on BSAI Alaska plaice prey availability.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having potentially negative or positive effects on BSAI Alaska plaice prey availability. Minimal research has been conducted on benthic invertebrates, the main prey species of Alaska plaice; therefore, the magnitude and direction of the effects imposed by climate changes and regime shifts are unknown.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potentially adverse contributor to the prey availability of BSAI Alaska plaice. Acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above the MSST. Climate changes and regime shifts are identified as potentially beneficial or adverse contributors to BSAI Alaska plaice prey availability. However, as stated above, since minimal research has been conducted on the effects of climate changes on benthic invertebrates, the magnitude and direction of the changes are unknown.

- **Cumulative Effects.** A cumulative effect has been identified for the BSAI Alaska plaice change in prey availability, and is rated as insignificant. The combination of internal and external removals of prey species is not expected to decrease prey availability such that the BSAI Alaska plaice stock is unable to maintain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** PA.1 and PA.2 would have an insignificant effect on Alaska plaice habitat suitability.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries have been identified as having negative effects on BSAI Alaska plaice habitat. See Sections 3.5.1.10 and 3.6 for more information on the effects of fishing gear on flatfish habitat. Climate changes and regime shifts are also identified as having a potentially negative or positive effect on Alaska plaice habitat. See Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to BSAI Alaska plaice habitat suitability. Acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success of Alaska plaice. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse contributions to BSAI Alaska plaice habitat suitability. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment is favored.

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

See Table 4.5-17 for a summary of the cumulative effects on BSAI Alaska plaice under PA.1 and PA.2.

BSAI Other Flatfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

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

Fishing Mortality

The catch of BSAI other flatfish in 2002 was estimated to be 2,600 mt. Model projections of future catch are shown in Table H.4-51 of Appendix H. Under PA.1, model projections indicate that the catch is expected to decrease from the 2002 value to 2,100 mt in 2003 and then increase to 2,300 mt in 2007 (14 percent decrease from 2002). The 2003-2007 average catch is 2,200 mt. The other flatfish fishery is likely to be limited by Pacific halibut PSC limits which are expected to decrease by 0-10 percent in the BSAI under PA.1 Under PA.2, model projects indicate that the catch is expected to decrease from a 2002 value of 2,600 mt to a 2006 value of 1,900 mt, and then increase to 2,100 mt through 2007. The 2003-2007 average projected catch is 1,900 mt. The other flatfish fishery is likely to be limited by Pacific halibut PSC limits which are expected to decrease by 0-20 percent in the BSAI under PA.2.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the ‘splitting and lumping’ of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future changes in Tier designation for BSAI other flatfish.

Given th low exploitation rates under PA.1 and PA.2, these FMPs are likely to have insignificant effects of the BSAI other flatfish species through mortality.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI other flatfish harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. As mentioned above, the other flatfish fishery may also be restricted temporally due to reductions in PSC limits. Existing closures would remain under this preferred alternative bookend.

The other flatfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-20 percent in the BSAI under PA.2. This, in combination with the evaluation of inseason bycatch closures (for hotspot areas), could temporally and spatially restrict the fishery. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

Status Determination

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

Under PA.1 and PA.2, the ABC must be set below the OFL. Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI other flatfish under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Under PA.2, OY caps would be recalculated for relevancy under existing environmental conditions and knowledge of stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Age and Size Composition

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

Sex Ratio

The sex ratios of the species in the BSAI other flatfish category are assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative bookend.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing

MPAs would be developed. These measures may help reduce adverse impacts to important flatfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may help reduce adverse impacts to BSAI flatfish habitat where overlap occurs, although, as stated above, impacts to flatfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on other flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 and PA.2. The direct forage fishery ban would continue under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI other flatfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under PA.1 and PA.2.
- **Persistent Past Effects.** Past effects have not been identified for BSAI other flatfish mortality.
- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.
- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other flatfish, and is rated as insignificant. Fishing mortality rates for projected years are well below the other flatfish OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.
- **Persistent Past Effects.** Past effects have not been identified for the BSAI other flatfish change in biomass level effect indicator.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other flatfish, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the spatial/temporal characteristics are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics are the same as those described for BSAI Alaska plaice under these bookends.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other flatfish catch; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** The effects on change in prey availability are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** The effects on change in prey availability are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the habitat suitability of BSAI other flatfish are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for habitat suitability are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for BSAI other flatfish habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

See Table 4.5-18 for a summary of the cumulative effects on BSAI other flatfish under PA.1 and PA.2.

GOA Rex Sole – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Estimates of total and spawning biomass are not available for this species.

Fishing Mortality

The catch of GOA rex sole in 2002 was estimated to be 3,000 mt. Model projections of future catch are shown in Table H.4-67 of Appendix H. Under PA.1, model projections indicate that the catch is expected to increase to 3,300 mt for each year 2003-2007. The 2003-2007 average value is 3,300 mt. Under PA.2, model projects indicate that catch is expected to decrease to 3,042 mt in 2007, with a 2003-2007 average of 3,068 mt. Rex sole catch may be limited in the GOA due to Pacific halibut PSC limits which are projected to be reduced by 0-20 percent under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA rex sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

Pacific halibut PSC limit reductions, in combination with the development of inseason bycatch closures, could actually spatially and temporally restrict the fishery, under PA.2 (see FMP 3.2 map [Figure 4.2-5] described in Section 4.2); however, the effects are unknown. Procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA rex sole.

Status Determination

The available information for GOA rex sole requires that they are classified into the Tier 5 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status. Under PA.1 and PA.2, the ABC must be set below the OFL. Under PA.1, the OY range for the GOA will be established between 116,000 and 800,000 mt and ecosystem indicators will be developed and used as part of the TAC-setting process. Under PA.2, OY caps would be revisited in light of existing environmental conditions and knowledge of stock levels. These measures may affect the catch limits for rex sole in the future under PA.1 and PA.2.

Age and Size Composition

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

Sex Ratio

The sex ratio of rex sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Current closure areas will remain under PA.1, including the eastern GOA trawl closure. A methodology for developing and adopting MPAs will be established and the program for identifying and designating EFH and HAPC will continue.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to GOA rex sole habitat where overlap occurs, although, as stated above, impacts to rex sole habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on rex sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. The directed forage fish ban will continue under this preferred alternative.

See Table 4.9-1 for a summary of the direct/indirect effects on GOA rex sole under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA rex sole stocks (see Section 3.5.1.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts are not considered to be contributing factors since the change in water temperatures would not likely be of sufficient magnitude to result in mortality of rex sole. Also the State of Alaska scallop fishery is not considered a contributing factor since it is not expected to contribute to direct mortality of rex sole.

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

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Large removals of rex sole by past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA rex sole stocks (see Section 3.5.1.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potentially beneficial or adverse effect on the rex sole biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. The State of Alaska Scallop Fishery is not considered to be a contributing factor since it is not expected to contribute to direct mortality of rex sole. For more information on climate changes and regime shifts see Sections 3.5.1.10 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA rex sole, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects**. Past effects are not identified for genetic structure of the population; however, climate changes and regime shifts are identified as having persistent past effects on the reproductive success of the GOA rex sole stock (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the genetic structure of rex sole include the potentially adverse effects of marine pollution since an acute and/or chronic pollution event could alter the genetic structure of the population by causing localized mortality. Neither the State of Alaska scallop fishery nor climate changes and regime shifts are considered to be contributing factors to the change in genetic structure of rex sole stocks. These events are not expected to cause localized depletions that would alter the genetic sub-population structure of rex sole stock. Change in reproductive success of rex sole due to climate changes and regime shifts are identified as having a potentially beneficial or adverse effect. Marine pollution has been identified as a potentially adverse effect since acute and/or chronic pollution events could also the reproductive success of GOA rex sole. Again, the State of Alaska scallop fishery is not a contributing factor since the scallop fishery is not expected to contribute to rex sole removals.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rex sole catch; however, this effect is unknown since it is not possible to determine MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had affected the prey availability of the GOA rex sole stock. The actual effect of climate changes and regime shifts on rex sole prey availability is unknown, but could have had a potential positive or negative effect (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on the GOA rex sole stock are potentially beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The State of Alaska scallop fishery has been identified as having a potentially adverse effect on rex sole prey availability since the habitat disturbances caused by dredging could influence the availability of benthic prey.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for GOA rex sole include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the GOA rex sole stock. See Sections 3.5.1.10 and 3.10). regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potentially beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as having potentially adverse effects on rex sole habitat suitability that may cause changes in the spawning or rearing success of the stock.

- **Cumulative Effects.** A cumulative effect is identified for GOA rex sole habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

See Table 4.5-19 for a summary of the cumulative effects on GOA rex sole under PA.1 and PA.2.

4.9.1.11 Pacific Ocean Perch

Pacific ocean perch (*Sebastes alutus*) are managed under Tier 3 in the BSAI and GOA.

BSAI Pacific Ocean Perch – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 374,000 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-53 of Appendix H.

Under PA.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 392,000 mt in 2007 with a 2003-2007 average value of 383,000 mt. Under PA.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 402,000 mt in 2007, with a 2003-2007 average value of 388,000 mt.

Spawning Biomass

Spawning biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 135,500 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-53 of Appendix H. Under PA.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 137,500 mt in 2007, with a 2003-2007 average value of 136,200 mt. Under PA.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 142,300 mt in 2007, with a 2003-2007 average value of 138,600 mt.

Fishing Mortality

Under PA.1, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is 0.033 in 2003, decreasing to 0.029 in 2005, and increasing 0.035 in 2007, with an average from 2003-2007 of 0.032 (Table H.4-53 of Appendix H).

Under PA.2, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is approximately 0.023 in each year from 2003 to 2007. The proportion of spawner biomass per recruit conserved under this fishing mortality rate is 60 percent (Table H.4-53 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under PA.1, a projected average of 10,600 mt of BSAI Pacific ocean perch are caught annually from 2003 to 2007, with about half of the harvest occurring in the eastern Aleutian Islands. The harvest in this area occurs largely from the directed fishery, although the Atka mackerel fishery is projected to harvest approximately 1,000 mt annually from 2003-2007.

As with PA.1, the eastern Aleutians Islands contributes the largest proportion of the BSAI Pacific ocean perch catch. The average annual projected catch from 2003-2007 was 7,830 mt, of which approximately half is expected to occur in the eastern Aleutian Islands. The directed Pacific ocean perch fishery accounted entirely for the Pacific ocean perch harvest in this area in 2003 and 2004, but from 2005-2006 the Atka mackerel fishery was projected to harvest approximately 1,000 mt of Pacific ocean perch annually from this region. A series of no-take reserves is also specified under PA.2, but comparison with the recent spatial distribution of the fishery indicates that substantial areas would remain open for Pacific ocean perch fisheries. The Pacific halibut PSC limits, which are projected to be reduced by 0-20 percent under this FMP, could restrict the Pacific ocean perch fishery if large amounts of bycatch were to occur.

Status Determination

Under PA.1 and PA.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are below ABC and OFL levels from 2003 to 2008. The projected spawning stock biomass is projected to be greater than the B_{MSY} ($B_{35\%}$)

level of 120,200 mt in each year of the projection, so BSAI Pacific ocean perch are above the MSST level under PA.1 and PA.2. Under PA.1, the BSAI OY is specified between 1.4 and 2.0 million mt. This means that if the sum of the TACs in the BSAI exceeds 2.0 million mt, TACs must be reduced. However, under PA.2, OY caps would be revisited for relevance under existing environmental conditions and stock levels. Ecosystem indicators will also be built into the TAC-setting process under these preferred alternative bookend. These measures could affect the future catch limits of BSAI Pacific ocean perch.

Age and Size Composition

Under PA.1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-53 of Appendix H), is 10.37 years. Under PA.2, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-53 of Appendix H), is 10.53 years. This compares with a mean age in the equilibrium unfished stock of 14.01 years.

Sex Ratio

The sex ratio of BSAI Pacific ocean perch is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this PA.1 or PA.2.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important Pacific ocean perch habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs or redesignating current closure areas as fishery- or gear-specific. A management area in the Aleutian Islands would be developed to protect coral and live bottom habitats and the EFH and HAPC identification and mitigation process would also be continued under PA.2. These measures could help to reduce the adverse impacts to BSAI Pacific ocean perch habitat where overlap occurs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on BSAI Pacific ocean perch.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had negative effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to BSAI Pacific ocean perch mortality since no bycatch is expected in this fishery. Marine pollution is identified as a potentially adverse contributor since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not expected to contribute to Pacific ocean perch mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific ocean perch, and it is rated as insignificant. Pacific ocean perch are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific ocean perch stock is expected to be insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had negative effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute significantly to BSAI Pacific ocean perch mortality since no bycatch is expected in this fishery. Therefore, the IPHC longline fishery is not expected to cause significant changes in biomass levels. Marine pollution is identified as a potentially adverse contributor since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as beneficial or adverse contributors to Pacific ocean perch change in biomass levels as a function of reproductive success.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Impacts of the spatial and temporal changes should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific ocean perch population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to changes in genetic structure or reproductive success of BSAI Pacific ocean perch since no bycatch of BSAI Pacific ocean perch is expected in this fishery. Marine pollution is identified as a potentially adverse contributor since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potentially beneficial or adverse contributors to reproductive success since changes in climate can affect prey availability and/or habitat suitability which in turn can affect recruitment. Generally, changes in climate changes that lead to increased advection of the Alaska current are believed to increase euphausiid production, a major prey item of BSAI Pacific ocean perch. Climate changes and regime shifts are not considered contributors to changes in genetic structure.

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

Change in Prey Availability

- **Direct/Indirect Effects.** PA.1 and PA.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific ocean perch prey species (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific ocean perch prey species are identified as potential beneficial or adverse contributors. In general, it is believed that climate changes and regime shifts that lead to the increased advection of the Alaska current also increase production of euphausiids, a major prey item of BSAI Pacific ocean perch. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** PA.1 and PA.2 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for BSAI Pacific ocean perch stocks include past foreign, JV, and domestic fisheries, IPHC longline fisheries, climate changes and regime shifts (see Section 3.5.1.11). Intense bottom trawling on Pacific ocean perch habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries are also identified as having negative effects on Pacific ocean perch habitat, although these fishing gear impacts are considered to be less significant than those associated with trawl gear (see Section 3.6 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both positive and negative effects on Pacific ocean perch habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is identified as having an adverse effect on Pacific ocean perch habitat through fishing gear impacts. As stated above, these impacts are expected to be of lesser magnitude than those effects associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific ocean perch stock are identified as potentially beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

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

See Table 4.5-20 for a summary of the cumulative effects on BSAI Pacific ocean perch under PA.1 and PA.2.

GOA Pacific Ocean Perch – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of GOA Pacific ocean perch at the start of 2003 is estimated to be 338,000 mt. Model projections of future total GOA Pacific ocean perch biomass are shown in Table H.4-77 of Appendix H. Under PA.1, model projections indicate that GOA Pacific ocean perch biomass is expected to increase to a value of 361,000 mt in 2007 with a 2003-2007 average value of 349,000 mt. Under PA.2, model projections indicate that GOA Pacific ocean perch biomass is expected to increase to a value of 376,000 mt in 2007 with a 2003-2007 average value of 358,000 mt.

Spawning Biomass

Spawning biomass of GOA Pacific ocean perch at the start of 2003 is estimated to be 112,700 mt. Model projections of future total GOA Pacific ocean perch biomass are shown in Table H.4-77 of Appendix H. Under PA.1, model projections indicate that GOA Pacific ocean perch biomass is expected to increase to a value of 115,500 mt in 2007, with a 2003-2007 average value of 113,200 mt. Under PA.2, model projections indicate that GOA Pacific ocean perch biomass is expected to increase to a value of 122,500 mt in 2007, with a 2003-2007 average value of 117,300 mt.

Fishing Mortality

Bycatch model results for PA.1 show catches comparable to FMP 1 for GOA Pacific ocean perch and therefore appear reasonable. Average fishing mortality during the years 2003 - 2007 is expected to be less than F_{OFL} (0.060) (Table H.4-77 of Appendix H).

PA.2 requires that appropriate harvest strategies be developed for rockfish. If these strategies were to use F_{60} as the basis for determining ABCs, then the catch of GOA Pacific ocean perch would be reduced because they are included in the slope rockfish assemblage. Under PA.2 the PSC limits for Pacific halibut could also be reduced by 0-10 percent. If the GOA Pacific ocean perch are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could also reduce catch of GOA Pacific ocean perch. Bycatch model results using F_{60} as a harvest strategy for PA.2 show catches reduced from FMP 1 for GOA Pacific ocean perch and therefore, appear reasonable. Average fishing mortality during the years 2003-2008 is expected to be less than F_{OFL} (0.060) (Table H.4-77 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effects that PA.1 has on the spatial and temporal concentration of Pacific ocean perch catch depends on the decisions made by NPFMC. The spatial distribution of catch would not be affected by proposed closures, and the apportionment of catch among management areas should provide some protection against localized depletion. Concentrating fishery effort into a short season would likely continue unless NPFMC implemented some “rights-based” management scheme.

The effects of PA.2 on the spatial and temporal concentration of Pacific ocean perch catch depends on the decisions made by NPFMC. The spatial distribution of catch would not be affected by proposed closures and apportionment of catch among management areas should provide some protection against localized depletion (see FMP 3.2 map [Figure 4.2-5] which illustrates the closures, similar to those proposed for PA.2; FMP 3.2 map is discussed in Section 4.2). The implementation of fishery rationalization should also spread out the fishery in time and space. PA.2 may also potentially have a large effect on the spatial concentration of Pacific ocean perch catch if 20 percent of the GOA is set aside as no-take reserves or as MPAs. Pacific ocean perch catches are taken in directed fisheries where the effort is highly localized and concentrated in slope areas. Much of this effort occurs in proposed closed areas. Therefore, if the proposed MPAs are closed to all bottom trawling, the spatial concentration of fishing effort would likely shift from the closure areas to the remaining open areas. The effect of shifting effort away from the closed areas is unclear.

Under PA.2 the spatial and temporal concentration of fishing effort may also be affected by Pacific halibut bycatch considerations if they substantially change the distribution of fishing effort.

Status Determination

Under PA.1 and PA.2, the projected 2003 biomass of 112,700 mt under PA.1, and 113,500 mt under PA.2, is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected 2005 biomass of 116,700 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition

Under PA.1 and PA.2, the age composition of GOA Pacific ocean perch may be changed under fishing pressure as in FMP 1. Size composition of GOA Pacific ocean perch might change in proportion to the change in age composition. Age and size composition could also change if Pacific halibut bycatch considerations substantially change the distribution of fishing effort. The projected average age at the end of 2007 for GOA Pacific ocean perch is 10.61 years under PA.1 and 10.85 years under PA.2, compared to a projected unfished population age of 14.33 years (Table H.4-77 of Appendix H).

Sex Ratio

No information is available to suggest that the sex ratio would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Under PA.1 damage to epifauna by bottom trawls may negatively impact juvenile Pacific ocean perch habitat. PA.1 may also positively affect habitat for GOA Pacific ocean perch because it maintains the eastern GOA closure to trawling. This provides a de facto no-take zone or refugium for Pacific ocean perch in this area and provides protection from the potential effects of trawling on adult and or juvenile rockfish habitat.

Under PA.2, bottom trawl damage to epifauna would likely be reduced due to less fishing pressure and would likely result in less impact to juvenile Pacific ocean perch habitat. PA.2 may also have a positive effect on the habitat of GOA Pacific ocean perch because it maintains the eastern GOA closure to trawling and proposes to set aside 0-20 percent of the GOA as no-take reserves or as marine protected areas (MPAs). If the proposed MPAs are closed to all bottom trawling, then additional refuges for Pacific ocean perch and/or protection of juvenile rockfish habitat from the potential effects of trawling could be provided in these zones.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA Pacific ocean perch.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for GOA Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA Pacific ocean perch is rated as insignificant. Pacific ocean perch are fished below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific ocean perch stock is expected to be insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

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

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

- **Direct/Indirect Effects.** Impacts of the spatial and temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects on the spatial and temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

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

Change in Prey Availability

- **Direct/Indirect Effects.** PA.1 and PA.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects**. Past effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** PA.1 and PA.2 would have insignificant effects on GOA Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

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

See Table 4.5-21 for a summary of the cumulative effects on GOA Pacific ocean perch under PA.1 and PA.2.

4.9.1.12 Thornyhead Rockfish

GOA thornyhead rockfish are described in more detail in Section 3.5.1.12 of this Programmatic SEIS. Until recently, thornyhead rockfish is managed as its own stock under the GOA Groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2004, thornyhead rockfish will be managed under Tier 5; however, for the purposes of this analysis, thornyhead rockfish were modeled as a Tier 3 species.

Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total (ages 5 through 55+) biomass of GOA thornyheads at the beginning of 2002 is estimated to be 54,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-78 of Appendix H. Under PA.1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt until 2003, then slowly increase to 55,000 mt by 2006, with a 2003-2007 average value of 55,000 mt. Under PA.2, model projections indicate that total GOA biomass is expected to remain at 54,000 mt in 2003, then slowly increase to 57,000 mt by 2007, with a 2003-2007 average value of 56,000 mt.

Spawning Biomass

Spawning biomass of female GOA thornyheads at the start of 2002 is estimated to be 23,500 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-78 of Appendix H. Under PA.1, model projections indicate that GOA spawning biomass is expected to increase to 23,600 mt by 2003, then slowly increase to 24,300 mt by 2007, with a 2002-2007 average value of 23,900 mt. Under PA.2, model projections indicate that GOA spawning biomass is expected to increase to 23,600 mt by 2004, and continue increasing to 25,200 mt by 2007, with a 2002-2007 average value of 24,400 mt.

Fishing Mortality

The average fishing mortality imposed on the GOA thornyhead stock in 2002 is projected to be 0.032 under current management. Under PA.1, fishing mortality is projected to decrease to 0.025 in 2003 and further decrease to 0.020 in 2007. PA.2 appropriate harvest strategies are to be developed for rockfish. Should these strategies use F_{60} as the harvest rule, then fishing mortality is projected to decrease to 0.013 in 2003 and further decrease to 0.012 in 2007. These values are well below the F_{MSY} proxy value of 0.102 which is the rate associated with the OFL (Table H.4-78 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Thornyhead catch is approximately evenly divided between longliners and trawlers under status quo management. There is nothing about PA.1 or PA.2 that is expected to change this. Longline catches are spatially dispersed along the continental shelf break throughout the GOA (Figure 4.5-1), and temporally dispersed due to the nature of the IFQ sablefish fishery. For example, longline thornyhead catches in 2000 occurred year-round, with peaks in April and September, that did not exceed 60 mt per week. Trawler catch has been more concentrated in time, with some catches of 20-40 mt per week occurring in late spring, with a single large peak of 160 mt per week in July of 2000, coinciding with the rockfish trawl fishery.

Between 1997 and 1999, thornyhead trawl catches appear to have become more concentrated in space (Figure 4.5-2). According to surveys, during 1997-1999, the distribution of thornyheads did not appear to change (Figure 4.5-3). This apparent concentration may be the indirect result of changes in the trawl fisheries for deepwater flatfish and rockfish since thornyheads are not a primary target of trawl fisheries. However, it should be noted that the overall catch of thornyheads is low relative to both the estimated biomass and the ABC, such that this apparent concentration of catch is unlikely to have any negative population effects.

Status Determination

The GOA thornyhead stock is not currently overfished. At 23,500 mt, spawning stock biomass is expected to remain well above both the $B_{35\%}$ level (14,681 mt) and the $B_{40\%}$ level (16,045 mt) during the year 2002 and will remain above $B_{40\%}$ in all projection years under PA.1 and PA.2. Under PA.1 and PA.2, the ABC must be set below the OFL and the GOA OY cap has been set between 116,000 and 800,000 mt. Ecosystem considerations will be implemented into the TAC-setting process under this bookend, which may result in changes to catch limits in the future.

Age and Size Composition

Under PA.1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-78 of Appendix H), is 10.15 years. Under PA.2, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-78 of Appendix H), is 10.35 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.67 years.

Sex Ratio

The sex ratio of GOA thornyheads is assumed to be 50:50. No information is available to suggest that this would change under PA.1 and PA.2.

Habitat-Mediated Impacts

Under PA.1, all current management measures would be maintained. The level of habitat disturbance under PA.1 (and FMP 1) does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMPs.

Under PA.2, all current management measures would be maintained. Furthermore, an Aleutian Islands management area would be established to protect coral and live bottom habitats. Pollock bottom trawling would be prohibited throughout the entire GOA and 0-20 percent of the GOA would be established as MPAs and no-take reserves. EFH and HAPC programs that identify, designate and implement mitigation measures would continue under PA.2. The level of habitat disturbance under FMP 1 (and PA.2) does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude whether or not existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMP.

Predation-Mediated Impacts

In the GOA, shortspine thornyheads prey on benthic invertebrates; according to the AFSC food habits database, much of their diet in the 1990s has been composed of shrimp. Thornyheads are rare in the diets of other groundfish, birds, or marine mammals in the GOA according to the present limited information. Therefore, the effects of status quo federal groundfish fisheries on trophic interactions involving GOA thornyheads are expected to be minor. The current levels and distribution of groundfish harvest do not appear to impact prey availability for thornyheads such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA thornyhead rockfish.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. The removals of thornyhead rockfish that occurred in these fisheries have had a lingering negative effect on the populations (see Section 3.5.1.12 for more information.

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

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

Change in Biomass Level

- **Direct/Indirect Effects.** PA.1 and PA.2 are expected to have insignificant effects on these stocks.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. Past removals by these fisheries have had a lingering negative effect on the GOA thornyhead rockfish populations (see Section 3.5.1.12 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the thornyhead rockfish biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, please see Sections 3.5.1.12 and 3.10. The IPHC longline fishery is identified as a potentially adverse contributor to the thornyhead rockfish biomass level since they are caught as bycatch in this fishery. The State of Alaska shrimp fishery is not considered to be a contributing factor since thornyhead rockfish bycatch is not expected in this fishery.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of thornyhead rockfish include contributions from climate changes and regime shifts which may be potentially beneficial or adverse. Marine pollution has also been identified as having a potentially adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA thornyhead rockfish. The IPHC longline fishery removals of thornyheads could be sufficiently concentrated as to alter the genetic structure and reproductive success of GOA thornyhead rockfish populations and are therefore identified as potentially adverse contributors. The State of Alaska shrimp fishery is not considered to be a contributing factor since bycatch of thornyhead rockfish is not expected in this fishery.

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the GOA thornyhead rockfish is expected to be insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do affect the availability of some prey species (i.e. shrimp); however, this has not been confirmed by scientific studies in the GOA.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock may be potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is not considered to be a contributing factor since bycatch of GOA thornyhead rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potentially adverse contributor to prey availability since removal of shrimp, the main prey species of GOA thornyhead rockfish, occurs in this fishery.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA thornyhead rockfish include climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery has been identified as a potential adverse contributor to GOA thornyhead rockfish habitat suitability. See Section 3.6 for information on the impacts of fishery gear on EFH. The State of Alaska shrimp fishery is not considered to be a contributing factor since habitat degradation by the shrimp fishery gear is not expected to occur.

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

See Table 4.5-22 for a summary of the cumulative effects on GOA thornyhead rockfish under PA.1 and PA.2.

4.9.1.13 Rockfish

Rockfish are considered in more detail in Section 3.5.1.13.

BSAI Northern Rockfish

Until recently, BSAI northern rockfish were a part of the BSAI red rockfish assemblage and evaluated under Tier 5. As of 2004, northern rockfish will be evaluated under Tier 3 with their own age-structured model, and the red rockfish group will no longer exist. However, for the purposes of this analysis, BSAI northern rockfish were modeled as a Tier 5 species.

Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

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

Fishing Mortality

The catch of BSAI northern rockfish in 2003 was estimated as 4,600 mt. Projected catches from 2003-2007 are shown in Table H.4-56 of Appendix H. Under PA.1, model projections indicate that the catch is expected to increase to 6,390 mt in 2003, then decrease to 5,510 mt in 2007. The 2003-2007 average catch is 5,790 mt. The northern rockfish fisheries may be limited by Pacific halibut PSC limits which are projected to decrease between 0-10 percent under PA.1. Under PA.2, appropriate harvest strategies for rockfish are to be developed. Should these strategies use F_{60}, then the projected catch is expected to decrease to 2,942 mt in 2003 and then increase through 2007 to 3,717 mt. The 2003-2007 average catch is 3,442 mt. The northern rockfish fisheries may be limited by Pacific halibut PSC limits which are projected to decrease between 0-20 percent under PA.2.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on BSAI northern rockfish through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Model projections indicate that the average harvest of 5,790 mt from 2003-2007 occurs largely in the eastern Aleutian Islands (approximately 55 percent), with 1,200 mt (22 percent) occurring in the central Aleutian Islands and 1,100 mt (19 percent) coming from the western Aleutian Islands. The harvest of northern rockfish in the each of these areas is taken largely in the Atka mackerel fishery. As stated above, the northern rockfish fisheries may be limited by Pacific halibut PSC limits under PA.1.

BSAI northern rockfish catch may be limited due to Pacific halibut PSC limits which are projected to be reduced by 0-25 percent under PA.2. Procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for BSAI rockfish.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST for northern rockfish cannot be determined. Under PA.1, the BSAI OY cap is established between 1.4 and 2.0 million mt. Under PA.2, OY caps would be revisited for relevancy with existing environmental conditions and knowledge of stock status. If the sum of the TACs for the BSAI target fish exceeds 2.0 million mt, than TACs must be reduced. As part of PA.1 and PA.2, ecosystem indicators would be implemented into the TAC setting process.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for this species. The sex ratio of BSAI northern rockfish is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.1 or PA.2.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important northern rockfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and an Aleutian Islands management area would be established to protect live bottom and coral habitat. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to BSAI rockfish habitat where overlap occurs, although, as stated above, impacts to rockfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI northern rockfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on BSAI northern rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of northern rockfish. The IPHC longline fishery is not considered a contributing factor since bycatch of BSAI northern rockfish is not expected to occur in this fishery.

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

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on BSAI northern rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the change in biomass level are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the northern rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery is not considered to be a contributing factor since bycatch of BSAI northern rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI northern rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI northern rockfish. Climate changes and regime shifts are identified as having a potentially beneficial/negative effect on BSAI northern rockfish (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potentially beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of northern rockfish. Marine pollution has been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI northern rockfish. The IPHC longline fishery is not considered to be a contributing factor to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in this fishery.

- **Cumulative Effects**. A cumulative effect is possible for the spatial/temporal concentration of the northern rockfish catch; however, this effect is unknown since it is not possible to determine the MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI northern rockfish stock. The actual effect of climate changes and regime shifts on northern rockfish prey availability is unknown, but could have had a potentially positive or negative effect (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery is not considered to be a contributing factor since it is unlikely that bycatch of northern rockfish prey species occurs in this fishery see Section 3.5.1.13 for more information on the trophic interactions of BSAI northern rockfish species.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI northern rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in northern rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on northern rockfish species habitat suitability, possibly having disrupted northern rockfish species spawning and/or rearing habitats. See Section 3.5.1.13 for more information on the past events that have effected northern rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potentially adverse effect on the northern rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt northern rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the northern rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

See Table 4.5-23 for a summary of the cumulative effects on BSAI northern rockfish under PA.1 and PA.2.

BSAI Shortraker/Rougheye Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

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

Fishing Mortality

The catch of BSAI shortraker/rougheye rockfish in 2003 was estimated as 570 mt. Projected catches from 2003-2007 are shown in Table H.4-57 of Appendix H. Under PA.1, model projections indicate that the catch is expected to range between 700 and 900 mt from 2003-2007, with an average of 800 mt. As stated above, the shortraker/rougheye rockfish fishery may be limited by Pacific halibut PSC limits. PA.2 requires that appropriate harvest strategies be developed for rockfish. Should these strategies use F_{60} to determine ABCs, then the projected catch is expected to decrease to 419 mt through 2007 with a 2003-2007 average catch is 419 mt. The rockfish fisheries may be limited by Pacific halibut PSC limits which are projected to decrease between 0-20 percent under PA.2.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on BSAI shortraker/rougheye rockfish through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Model projections indicate that the average harvest of 800 mt from 2003-2007 is relatively evenly spread among the three Aleutian Islands subareas, with between 26 percent and 32 percent of the harvest occurring in each subarea. The harvest in the western and eastern Aleutian Islands occurs largely in the Pacific ocean perch trawl fishery, whereas the harvest in the central Aleutian Islands occurs largely in the Pacific cod longline fishery. The shortraker/rougheye rockfish fishery may be limited by Pacific halibut PSC limits which are expected to decrease by 0-10 percent under PA.1.

BSAI shortraker/rougheye rockfish catch may be limited due to Pacific halibut PSC limits which are projected to be reduced by 0-25 percent under PA.2. Procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for BSAI rockfish.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST for this stock cannot be determined. Under PA.1, the BSAI OY cap is established between 1.4 and 2.0 million mt. If the sum of the TACs for the BSAI target fish exceeds 2.0 million mt, than TACs must be reduced. Under PA.2, calculations of OY caps would be revisited for relevance with existing environmental conditions and knowledge of stock status. As part of PA.1 and PA.2, ecosystem indicators would be implemented into the TAC setting process.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. The sex ratio of BSAI shortraker/rougheye rockfish is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.1 or PA.2.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important shortraker/rougheye rockfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and an Aleutian

Islands management area would be established to protect live bottom and coral habitat. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to BSAI rockfish habitat where overlap occurs, although, as stated above, impacts to rockfish habitat suitability are unknown.

<u>Predation-Mediated Impacts</u>

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and the State of Alaska shrimp fishery are not considered to be contributing factors since bycatch of BSAI shortraker/rougheye rockfish is not expected to occur in these fisheries.

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

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the fishery on biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery and the State of Alaska shrimp fishery are not considered to be contributing factors since bycatch of BSAI shortraker/rougheye rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

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

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI shortraker/rougheye rockfish. Climate changes and regime shifts are identified as having a potentially beneficial/negative effect on BSAI shortraker/rougheye rockfish (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the reproductive success of shortraker/ rougheye rockfish due to climate changes and regime shifts are potentially beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of shortraker/rougheye rockfish. Marine pollution has been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery are not considered to be contributing factors to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the shortraker/rougheye rockfish catch; however, this effect is unknown since is not possible to determine the MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI shortraker/rougheye rockfish stock. The actual effect of climate changes and regime shifts on shortraker/rougheye rockfish prey availability is unknown, but could have had a potential positive or negative effect (see Sections 3.5.1.13 and 3.10).

- **Reasonable Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery is not considered a contributing factor since it is unlikely that bycatch of shortraker/rougheye rockfish prey species occurs in this fishery. The State of Alaska shrimp fishery is identified as a potentially adverse contributor to BSAI shortraker/rougheye prey availability since shrimp is on e of the main prey species of rougheye rockfish. See Section 3.5.1.13 for more information on the trophic interactions of BSAI shortraker/rougheye rockfish species.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI shortraker/rougheye rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in shortraker/rougheye rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on shortraker/ rougheye rockfish species habitat suitability, possibly having disrupted shortraker/rougheye rockfish species spawning and/or rearing habitats. The State of Alaska shrimp fishery is not considered a contributing factor to shortraker/rougheye rockfish habitat suitability since habitat degradation by shrimp fishery gear is not expected to occur. See Section 3.5.1.13 for more information on the past events that have effected shortraker/rougheye rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potentially adverse effect on the shortraker/rougheye rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt shortraker/rougheye rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, this effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the shortraker/rougheye rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

See Table 4.5-24 for a summary of the cumulative effects on BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

BSAI Other Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

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

Fishing Mortality

Under PA.1, the projected catch of Aleutian Islands other rockfish in 2003 to 2007 ranged from 200 mt to 300 mt, with and average of 260 mt. The projected harvest of EBS other rockfish from 2003 to 2007 was about 100 mt in each year. Projected catches from 2003-2007 are shown in Tables H.4-54 and H.4-55 of Appendix H. Under PA.2, appropriate harvest strategies for rockfish are to be developed. Should these strategies use F_{60} as the harvest rule, then the projected catch of EBS other rockfish is expected to decrease to 72 mt in 2003 and continue to decrease through 2007 to 66 mt. The 2003-2007 average catch is 69 mt. The projected catch of Aleutian Islands other rockfish is expected to decrease to 151 mt in 2003 and continue to decrease through 2007 to 130 mt. The 2003-2007 average catch is 140 mt. These projections suggest that direct fishing mortality on other rockfish stocks will be very low relative to the OFL and that such harvest levels will not present any significant impact to the species ability to maintain current population levels. Other rockfish fisheries may be limited by Pacific halibut PSC limits which are expected to decrease by 0-10 percent under PA.1. The rockfish fisheries may be limited by Pacific halibut PSC limits which are projected to decrease between 0-20 percent under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

In the Aleutian Islands, 89 percent of the average harvest of 300 mt occurs in the cental and western Aleutian Islands, taken largely in the Atka mackerel and Pacific cod trawl fisheries and the Pacific cod and sablefish longline fisheries. In the EBS, the average catch of 100 mt is taken largely in the Pacific cod and Greenland turbot bottom trawl fisheries and the sablefish and Greenland turbot longline fisheries. No significant changes are expected in the spatial and temporal concentration of catch as a result of reduced other rockfish TACs.

BSAI rockfish catch may be limited due to Pacific halibut PSC limits which are projected to be reduced by 0-25 percent under PA.2. Procedures to account of uncertainty when establishing ABC values would be developed, implemented, and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for BSAI rockfish.

Status Determination

The fishing mortality rate is below the ABC and OFL for all years. The MSST is unable to be determined. Under PA.1, the BSAI OY cap is established between 1.4 and 2.0 million mt. If the sum of the TACs for the BSAI target fish exceeds 2.0 million mt, than TACs must be reduced. Under PA.2, OY caps would be recalculated in light of existing environmental conditions and current knowledge of stock levels. As part of PA.1 and PA.2, ecosystem indicators would be implemented into the TAC setting process.

Age and Size Composition and Sex Ratio

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

Habitat-Mediated Impacts

Any habitat related impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude whether existing habitat conditions would undergo any significant change under PA.1 or PA.2.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important rockfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and an Aleutian Islands management area would be established to protect live bottom and coral habitat. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to BSAI rockfish habitat where overlap occurs, although, as stated above, impacts to rockfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat suitability impacts, any effect on predator-prey relationships of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude whether trophic interactions would undergo any significant change as a result of the PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on Aleutian Islands and EBS other rockfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under PA.1 and PA.2.

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

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are the same as those considered for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

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

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Past effects on the change in biomass level are the same as those indicated for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are the same as those indicated for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other rockfish, but is the effect is unknown. It is unknown whether the combined effect of internal external and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

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

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is rated as unknown.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal characteristics of BSAI other rockfish catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of other rockfish are the same as those considered for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other rockfish catch, but this effect is unknown since it is not possible to calculate the MSST. However, the spatial and temporal concentration of the fishery is not expected to change significantly.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in prey availability are the same as those described for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those described for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in habitat suitability are the same as those considered for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability are the same as those considered for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** The cumulative effect of habitat suitability is unknown. It is unknown whether the combined effect will make the other rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

See Table 4.5-25 for a summary of the cumulative effects on BSAI other rockfish under PA.1 and PA.2.

GOA Northern Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of GOA northern rockfish at the start of 2003 is estimated to be 112,000 mt. Model projections of future total GOA northern rockfish biomass are shown in Table H.4-76 of Appendix H. Under PA.1, model projections indicate that GOA northern rockfish biomass is expected to decrease to a value of 101,000 mt in 2007, with a 2003-2007 average value of 104,000 mt. Under PA.2, model projections indicate that GOA northern rockfish biomass is expected to decrease to a value of 103,000 mt in 2007, with a 2003-2007 average value of 105,000 mt.

Spawning Biomass

Spawning biomass of GOA northern rockfish at the start of 2003 is estimated to be 42,700 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-76 of Appendix H. Under PA.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 37,600 mt in 2007, with a 2003-2007 average value of 40,200 mt. Under PA.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 38,400 mt in 2007, with a 2003-2007 average value of 40,700 mt.

Fishing Mortality

Under PA.1 the PSC limits for Pacific halibut are reduced by ten percent. If the GOA northern rockfish are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could reduce catch of GOA northern rockfish as well. Average fishing mortality during the years 2003 - 2008 is expected to be less than F_{OFL} (0.066) (Table H.4-76 of Appendix H).

PA.2 requires that appropriate harvest strategies be developed for rockfish. If these strategies were to use F_{60} as the basis for determining ABCs, then catch of GOA northern rockfish would be reduced. Under PA.2 the PSC limits for Pacific halibut are also reduced by 30 percent. If the GOA northern rockfish are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could reduce catch of GOA northern rockfish as well. Average fishing mortality during the years 2003-2008 is expected to be less than F_{OFL} (0.066) (Table H.4-76 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effects that PA.1 and PA.2 has on the spatial and temporal concentration of northern rockfish catch depends on the decisions made by NPFMC. The spatial distribution of catch would not be affected by proposed closures, and apportionment of catch among management areas should provide some protection against localized depletion. Concentrating fishery effort into a short season would likely continue unless NPFMC implemented some rights-based management scheme. Under PA.1 and PA.2 the spatial and temporal concentration of fishing effort may also be affected by Pacific halibut bycatch considerations if they substantially change the distribution of fishing effort. Under PA.1, the potential for localized depletion of the stock exists if fishing occurs year after year on localized aggregations of northern rockfish.

Under PA.2, the implementation of fishery rationalization should also spread the fishery out in time and space. PA.2 may also potentially have a large effect on the spatial concentration of northern rockfish catch if the maximum proposal of 20 percent of the GOA is set aside as no-take reserves or as MPAs. Northern rockfish catches are taken in directed fisheries where the effort is highly localized and concentrated in slope areas. Much of this effort occurs in proposed closed areas. Therefore, if the proposed MPAs are closed to all bottom trawling, the spatial concentration of fishing effort would likely shift from the closure areas to remaining open areas. The effect of shifting effort away from the closed areas is unclear, but since fishing effort is highly localized the spatial distribution of catch is likely to change.

Status Determination

Under PA.1 and PA.2, the projected 2003 biomass of 42,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected 2005 biomass of 40,400 mt under PA.1, and 40,800 mt under PA.2, is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition. The ABC must be set below the OFL under both bookends. As part of PA.1, the GOA OY cap is established between 116,000 and 800,000 mt. However, under PA.2, OY caps would be recalculated for relevancy under existing environmental conditions and knowledge of stock levels.

Age and Size Composition and Sex Ratio

Under PA.1 and PA.2, the age composition of GOA northern rockfish may be affected by fishing mortality as in FMP 1. Size composition of GOA northern rockfish might change in proportion to the change in age composition. Age and size composition could also change if Pacific halibut bycatch considerations substantially change the distribution of fishing effort. No information is available to suggest that sex ratio would change under PA.1.

Habitat-Mediated Impacts

Under PA.1, damage to epifauna by bottom trawls may negatively impact juvenile northern rockfish habitat. Existing closures would remain under PA.1, including the eastern GOA trawl closure. EFH and HAPC identification and designation programs would also be continued. NPFMC and NOAA Fisheries would also develop a methodology for establishing MPAs.

Under PA.2 damage to epifauna by bottom trawls would likely be reduced under less fishing pressure and result in less impact on juvenile northern rockfish habitat. PA.2 may also have a positive effect on the habitat of GOA northern rockfish because it proposes to set aside 0-20 percent of the GOA as no-take reserves or as MPAs. If these MPAs are closed to all bottom trawling, then they may serve as refugia for northern rockfish allowing for increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. If these MPAs are closed to all bottom trawling, then they would also provide protection from the potential effects of trawling on juvenile rockfish habitat in these areas. The proposed ban on GOA pollock bottom trawling is likely to have a beneficial effect on juvenile rockfish habitat.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under PA.1 or PA.2.

See Table 4.9-1 for the summary of direct/indirect effects of GOA northern rockfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries are identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered contributors to northern rockfish mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA northern rockfish, and is rated as insignificant. Northern rockfish are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA northern rockfish stock is expected to be insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries are identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Bycatch in the IPHC longline fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as having beneficial or adverse contributions to northern rockfish change in biomass levels as a function of change in reproductive success.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects**. Impacts of the spatial and temporal characteristics of GOA northern rockfish should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure . However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** As noted above, the IPHC longline fishery has already been accounted for by domestic groundfish management and is not expected to contribute to changes in genetic structure or reproductive success of northern rockfish. Marine pollution is identified as having a potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potentially beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. The magnitude and direction of the change in reproductive success with water temperatures is currently unknown. Climate changes and regime shifts are not considered to be contributors to change in genetic structure.

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

Change in Prey Availability

- **Direct/Indirect Effects**. PA.1 and PA.2 would have an insignificant effect on northern rockfish prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on northern rockfish prey species (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since northern rockfish prey species bycatch is not expected to occur. Climate changes and regime shifts are identified as having potentially beneficial or adverse contributions on prey availability, although the magnitude and the direction of change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

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

Change in Habitat Suitability

- **Direct/Indirect Effects**. PA.1 and PA.2 would have an insignificant effect on northern rockfish habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA northern rockfish stocks include past foreign, JV, and domestic fisheries, IPHC longline fishery and climate changes and regime shifts (see Section 3.5.1.13). Intense bottom trawling on northern rockfish habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries have also been identified as having negative effects on northern rockfish habitat, although these effects are not expected to have been as intense as those effects associated with trawl gear. See Section 3.6 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both positive and negative effects on northern rockfish habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has been identified as an adverse contributing factor since the fishery gear could disrupt spawning and/or rearing habitats. Although, as stated above, the impacts associated with longline gear are not as significant as those associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the GOA northern rockfish stock are identified as potentially beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

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

See Table 4.5-26 for a summary of the cumulative effects on GOA northern rockfish under PA.1 and PA.2.

GOA Shortraker/Rougheye Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter.

Fishing Mortality

PA.1 is more precautionary in its approach than FMPs 1, 2.1, and 2.2. However, for most measures in regards to shortraker/rougheye it remains very similar to FMP 1 and the baseline situation. One would therefore expect the catch projections for shortraker/rougheye in this bookend would be very similar to those in FMP 1. The projections, however, are consistently higher for PA.1, which does not appear reasonable (Table H.4-75 of Appendix H). Under PA.1, these projections indicate an increase from the 2002 value of 1,300 mt to 1,418 mt in 2003, and then decrease to 1,231 mt in 2007. The 2003-2007 average projected catch is 1,272 mt. PA.2 requires that appropriate harvest strategies be developed for rockfish. If those strategies were to use F_{60} to determine ABCs, then projections indicate a decrease in catch to 679 mt through 2005, and an increase through 2007 to 776. The 2003-2007 average projected catch under PA.2 is 724 mt.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA rockfish.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on GOA shortraker/rougheye rockfish through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Whether PA.1 would have substantial effects on the spatial or temporal concentration of shortraker/rougheye catch would somewhat depend on decisions made by NPFMC after the bookend was implemented. ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. IFQs and fishing cooperatives may be established as needed, but since specific recommendations concerning such rights-based management are not included in the FMP, it is difficult to evaluate how they would impact shortraker/rougheye. If NPFMC decided to not establish IFQs and/or cooperatives for trawlers, the shortraker/rougheye trawl catch would continue to be concentrated into relatively short open seasons. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

PA.2 would have a large effect on the spatial and temporal concentration of GOA rockfish catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because PA.2 sets aside 0-20 percent of the GOA as either no-take reserves or as MPAs. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. The rockfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-10 percent in the GOA under PA.2. Hence, if PA.2 were adopted, an indirect effect might be to reduce catches of rockfish if means were not found to control or prevent Pacific halibut bycatch. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

PA.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called race for fish would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be determined. As part of PA.1 and PA.2, the GOA OY cap is established between 116,000 and 800,000 mt. Under PA.2, OY caps would be reconsidered under existing environmental conditions and knowledge of stock levels. The ABC must be set below the OFL under these FMPs. A measure in PA.2 that would affect catch of rockfish is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of rockfish, thereby providing even greater protection against overfishing.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter. There is no information on the sex ratio of shortraker/rougheye, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by PA.1 or PA.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, PA.1 may impact habitat for shortraker/rougheye because it closes the eastern GOA to trawling. This closure prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of shortraker/rougheye, an undamaged benthic habitat may benefit these species. For example, observations from a manned submersible in the eastern GOA have found shortraker and/or rougheye rockfish associated with boulders along steep slopes (Krieger and Ito 1999) and with colonies of Primnoa coral (Krieger and Wing 2002). The eastern GOA trawl closure presumably causes a reduction in the alteration or destruction of these habitats, which may have a positive effect on shortraker/rougheye in this region.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation would be measures instituted as needed. These measures may provide substantial habitat benefits to GOA rockfish.

Predation-Mediated Impacts

Pacific cod, and to a lesser extent walleye, pollock are species that are known to prey on shrimp, a major prey item of rougheye rockfish, so any changes in their abundance as a result of PA.1 and PA.2 hypothetically could affect the food supply of shortraker/rougheye. To protect Steller sea lions, PA.1 has two measures that could reduce the catch and increase the abundance of Pacific cod and walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for two species. Under PA.2, catch projections for walleye pollock indicate catches would be reduced compared to FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1, and abundance of walleye pollock would somewhat increase. However, whether a change in abundance of Pacific cod or walleye pollock would actually affect the food supply for shortraker/rougheye is unknown, as there is no quantitative information on trophic interactions between all these species. Moreover, shortraker and rougheye rockfish reside in deeper depths than Pacific cod or walleye pollock, so they may not be competing for the same spatial aggregations of food.

The direct/indirect effects of PA.1 and PA.2 on shortraker/rougheye in the GOA are summarized in Table 4.9-1.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are not considered contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery are not considered contributing factors since bycatch of rockfish species is not expected to occur in these fisheries.

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

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery and State of Alaska shrimp are not considered contributing factors to GOA slope rockfish biomass level since bycatch is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

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

- **Direct/Indirect Effects.** The spatial/ temporal characteristics of GOA shortraker/rougheye rockfish under PA.1 and PA.2 are unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA shortraker/rougheye rockfish; however, climate changes and regime shifts have been identified as having had potential positive or negative effects on shortraker/rougheye rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to GOA shortraker/rougheye rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are not considered contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The IPHC longline fishery and the State of Alaska shrimp fishery are not considered contributing factors to the change in genetic structure and reproductive success of GOA shortraker/rougheye rockfish since bycatch in these fisheries is unlikely to occur.

- **Cumulative Effects.** A cumulative effect for the spatial and temporal characteristics of the GOA shortraker/rougheye rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA shortraker/rougheye rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had positive or negative effects on shortraker/rougheye rockfish prey availability (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to shortraker/rougheye rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability (see Sections 3.5.1.13 and 3.10). The IPHC longline fishery is not considered contributing factor to shortraker/rougheye rockfish prey availability since bycatch of shortraker/rougheye rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since shrimp is a main prey item of rougheye rockfish.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA shortraker/rougheye rockfish; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under PA.1 and PA.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent negative effects on GOA shortraker/rougheye rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past positive or negative effects on GOA shortraker/rougheye rockfish habitat suitability (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potentially beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability (see Sections 3.5.1.13 and 3.10). The IPHC longline fishery has been identified as a potentially adverse contributor to shortraker/rougheye rockfish habitat suitability due to impacts from fishery gear. The State of Alaska shrimp fishery is not considered contributing factor since habitat degradation from shrimp fishery gear is not expected to occur (see Section 3.6).

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

See Table 4.5-27 for a summary of the cumulative effects on GOA shortraker/rougheye rockfish under PA.1 and PA.2.

GOA Slope Rockfish – Direct/Indirect Effects of PA.1 and PA.2

The average exploitable biomass for the other slope rockfish groups are placed in Tier 5 where ABC is determined by F = 0.75M. Sharpchin are assessed under Tier 4 where OFL is calculated by F = M.

Total and Spawning Biomass

No projections are possible for these two parameters, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Fishing Mortality

PA.1 is more precautionary in its approach than FMPs 1, 2.1, and 2.2. However, for most measures in regards to slope rockfish it remains very similar to the baseline FMP 1. For example, the eastern GOA trawl closure is retained in this bookend, which means most of the GOA population of slope rockfish will not be vulnerable to fishing. The model projections for PA.1, however, show ABCs much less than those for FMP 1, whereas the catches for PA.1 are slightly higher than those for FMP 1. Therefore, the model results do not seem plausible (Table H.4-72 of Appendix H). Under PA.1, these projections indicate an increase from the 2002 value of 572 mt to 980 mt in 2004, and then decrease to 944 mt in 2007. The 2003-2007 average projected catch is 960 mt. PA.2 requires that appropriate harvest strategies be developed for rockfish. Should F_{60} be used as a harvest rule, then projections indicate an increase in catch to 712 mt in 2003, a decrease through 2005 to 672 mt, and then an increase through 2007 at 745 mt. The 2003-2007 average projected catch under PA.2 is 705 mt.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the ‘splitting and lumping’ of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA rockfish.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on GOA slope rockfish through mortality.

Spatial/Temporal Concentration of Fishing Mortality

The main spatial effect of PA.1 on slope rockfish would be caused by the bookend's retention of the eastern GOA trawl closure, which would mean most of the GOA population of slope rockfish would not be vulnerable to fishing. If this bookend was implemented, the only slope rockfish catch would be taken by trawl west of the closure area and by longline mostly in the eastern GOA. There have been no studies to determine stock structure for any species of slope rockfish, and it is unknown if subpopulations exist. However, because most of the biomass of slope rockfish occurs in the eastern GOA, localized depletion is unlikely under this FMP. Whether this bookend would have much effect on the temporal concentration of slope rockfish catch would depend on decisions made by NPFMC after the bookend was implemented. PA.1 states that IFQs and fishing cooperatives may be established as needed, but since specific recommendations concerning such rights-based management are not included in the FMP, it is difficult to evaluate how they would impact slope rockfish. If NPFMC decided to not establish IFQs and/or cooperatives for rockfish trawlers, most of the slope rockfish catch could continue to be concentrated into a relatively short open season. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

PA.2 would have a large effect on the spatial and temporal concentration of GOA rockfish catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because PA.2 sets aside 0-20 percent of the GOA as either no-take reserves or as MPAs. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. The rockfish fishery may be restricted by Pacific halibut PSC limits, which are projected to b reduced by 0-10 percent in the GOA under PA.2. Hence, if PA.2 were adopted, an indirect effect might be to reduce catches of rockfish if means were not found to control or prevent Pacific halibut bycatch. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

PA.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called race for fish would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

No projections are possible for the fishing mortality rate or MSST, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter. As part of PA.1, the GOA OY cap is established between 116,000 and 800,000 mt. The ABC must be set below the OFL under PA.1. PA.2 revisits the OY caps to determine relevancy to current environmental conditions and knowledge of current stock levels. This would result in a decreased catch for rockfish and greatly reduce any risk of overfishing these species. One other measure in PA.2 that would affect catch of rockfish is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of rockfish, thereby providing even greater protection against overfishing.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. There is no information on the sex ratio of slope rockfish, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by PA.1 or PA.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, PA.1 greatly impacts habitat for slope rockfish because it closes the eastern GOA to trawling. This creates a de facto no-take zone or refuge for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species. Nearly all the biomass of slope rockfish is found in the eastern GOA, which means the trawl closure in this region protects most of the GOA population from any fishing pressure.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation would be measures instituted as needed. These measures may provide substantial habitat benefits to GOA rockfish.

Predation-Mediated Impacts

No studies have been done in Alaska to determine the food habits for any of the slope rockfish species. Many of the abundant species, such as sharpchin, harlequin, and redstripe rockfish, are relatively small in size and may be plankton-feeders, but this is conjecture. There is also no documentation of predation on slope rockfish, although larger fishes such as Pacific halibut that are known to prey on other rockfish presumably also prey on slope rockfish. Because of this lack of information, the effect of PA.1 and PA.2 on predator-prey relationships for slope rockfish is unknown.

The direct/indirect effects of PA.1 and PA.2 on slope rockfish in the GOA are summarized in Table 4.9-1.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries and State of Alaska groundfish fisheries have been identified as having had a negative persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of other slope rockfish. The State of Alaska groundfish fisheries is also not considered a contributing factor since catch and bycatch of slope rockfish species is already accounted for by the domestic groundfish fishery management. In addition, the IPHC longline fishery is not considered a contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

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

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effect.** Future external effects on the change in biomass level are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the other slope rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The State of Alaska groundfish fisheries are not considered contributing factors to GOA slope rockfish biomass level. Although catch and bycatch do occur in these fisheries, the removals are already accounted for by the domestic groundfish fishery management.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA other slope rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

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

- **Direct/Indirect Effects.** The spatial/temporal characteristics of GOA slope rockfish under PA.1 and PA.2 are unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA slope rockfish; however, climate changes and regime shifts have been identified as having had potential positive or negative effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to GOA slope rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are not considered contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The State of Alaska groundfish fishery is not considered a contributing factor to the change in genetic structure and reproductive success of GOA slope rockfish. Although catch and bycatch of slope rockfish species occurs in these fisheries, they are not expected to contribute to localized depletion such that it leads to a detectable reduction in genetic diversity or reproductive success. The IPHC longline fishery is also not considered a contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect for the spatial and temporal characteristics of the GOA slope rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA slope rockfish complex.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The change in prey availability under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had positive or negative effects on slope rockfish prey availability (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to slope rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability (see Sections 3.5.1.13 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery are not considered contributing factors to slope rockfish prey availability since bycatch of slope rockfish prey species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA slope rockfish; however, the effect is unknown due to lack of scientific information.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under PA.1 and PA.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, State of Alaska groundfish fisheries and the IPHC longline fisheries have been identified as having past persistent negative effects on GOA slope rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past positive or negative effects on GOA slope rockfish habitat suitability (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could have a potentially beneficial or adverse contribution on slope rockfish habitat suitability (see Sections 3.5.1.13 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery have been identified as potentially adverse contributors to slope rockfish habitat suitability due to impacts from fishery gear (see Section 3.6).

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

See Table 4.5-27 for a summary of the cumulative effects on GOA slope rockfish under PA.1 and PA.2.

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish. Until recently, an age-structured model had not been finalized for dusky rockfish. As of 2004, dusky rockfish will be evaluated under Tier 3; however, for the purposes of this analysis, dusky rockfish were modeled under Tier 4.

Fishing Mortality

PA.1 is more precautionary in its approach than FMPs 1, 2.1, and 2.2. However, for most measures in regards to PSR it remains very similar to FMP 1 and the baseline situation. One measure in PA.1 that could affect catch of PSR is that PSC limits for Pacific halibut are reduced 0-10 percent. In at least one instance in recent years, the PSR fishery has been closed early with substantial TAC remaining so that excessive bycatch of halibut would be prevented. Hence, if PA.1 were adopted, an indirect effect might be to reduce catches of PSR if means were not found to control or prevent Pacific halibut bycatch. The model projections for PA.1 show catches about 25 percent less than those for FMP 1, which may be plausible given the reduced PSC limits for Pacific halibut (Table H.4-73 of Appendix H).

Under PA.1, these projections indicate a decrease from the 2002 value of 3,318 mt to 1,657 mt through 2007. The 2003-2007 average projected catch is 1,735 mt. PA.2 requires that appropriate harvest strategies be developed for rockfish. If those strategies were to use F_{60} to determine ABCs, then projections indicate a decrease to 1,086 mt through 2005, and an increase through 2007 to 1,372 mt. The 2003-2007 average projected catch under PA.2 is 1,222 mt.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA rockfish.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on GOA PSR through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Whether PA.1 would have substantial effects on the spatial or temporal concentration of PSR catch would somewhat depend on decisions made by NPFMC after the bookend was implemented. ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. IFQs and fishing cooperatives may be established as needed, but since specific recommendations concerning such rights-based management are not included in the FMP, it is difficult to evaluate how they would impact PSR. If NPFMC decided to not establish IFQs and/or cooperatives for rockfish trawlers, the PSR fishery could continue to be concentrated into a relatively short open season. Similar to the baseline, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

PA.2 would have a large effect on the spatial and temporal concentration of GOA rockfish catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because PA.2 sets aside 0-20 percent of the GOA as either no-take reserves or as MPAs. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. The rockfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-10 percent in the GOA under PA.2. Hence, if PA.2 were adopted, an indirect effect might be to reduce catches of rockfish if means were not found to control or prevent Pacific halibut bycatch. However, the effects of these measures on the spatial and temporal characteristics of the stock complex are unknown.

PA.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called race for fish would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be determined for this stock. One measure in PA.2 that would affect catch of rockfish is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of rockfish, thereby providing even greater protection against overfishing.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish. There is no information on the sex ratio of PSR, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by PA.1 or PA.1 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, PA.1 impacts habitat for PSR because it retains the eastern GOA trawl closure. This creates a de facto no-take zone or refuge for PSR in this area, as trawls are generally the only effective gear for capturing these species. Although biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA only contains about 10-15 percent of the GOA biomass of dusky biomass, this is still large enough that it may provide enhanced protection to the dusky rockfish resource. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. The trawl closure also prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of PSR, an undamaged benthic habitat likely provides a benefit to these species. For example, observations from manned submersibles in the eastern GOA have found adult dusky rockfish associated with colonies of Primnoa coral (Krieger and Wing 2002) and with large vase-type sponges. Prevention of possible damage by bottom trawls to these living substrates may increase the amount of protective cover available to dusky rockfish to escape predation and thus have a positive impact on the stocks. Juvenile dusky rockfish may also be associated with epifauna such as corals or sponges that provide structural relief on the bottom. If so, reducing the damage to this epifauna by bottom trawls may increase survival of juvenile fish.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may provide substantial habitat benefits to GOA rockfish.

Predation-Mediated Impacts

The major prey of dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). Euphausiids are also the major prey of walleye pollock, which means dusky rockfish and walleye pollock may be competing for the same food resource. Thus, any measures in PA.1 that affect the commercial catch of walleye pollock could have a subsequent indirect effect on dusky rockfish by increasing or decreasing the amount of euphausiids available to dusky rockfish. To protect Steller sea lions, PA.1 (similar to FMP 1 and the baseline situation in past years) has two measures that may reduce catch of walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for walleye pollock. Catch projections for walleye pollock in PA.2 indicate catches would be reduced compared to FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1., and abundance of walleye pollock would somewhat increase. Hypothetically, these measures could increase the abundance of walleye pollock, resulting in the consumption of more euphausiids and having an adverse effect on the food supply for dusky rockfish. How adverse this effect would really be, however, is unknown, as there is little or no quantitative information on trophic interactions between dusky rockfish and walleye pollock or data on whether they even feed on the same spatial aggregations of euphausiids.

The direct/indirect effects of PA.1 and PA.2 on PSR in the GOA are summarized in Table 4.9-1.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of the fisheries on the mortality of the GOA PSR complex is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering negative effect on the GOA PSR population (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery is not considered to be a contributing factor to GOA PSR mortality since no bycatch is expected in this fishery. Marine pollution is identified as a potentially adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not considered to be contributors to PSR mortality.

- **Cumulative Effects**. A cumulative effect identified for mortality of GOA PSR is rated as insignificant. PSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effect of fisheries on the biomass level under PA.1 and PA.2 is unknown since the MSST cannot be determined.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering negative effect on the GOA DSR population (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery is not considered a contributing factor to GOA PSR biomass levels since no bycatch is expected in this fishery. Marine pollution is identified as a potentially adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not considered contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass; however, the effect is unknown since total and spawning biomass levels and MSST are currently unavailable.

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA PSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects**. No persistent past effects have been identified for the change in genetic structure of GOA PSR; however, climate changes and regime shifts have been identified as having had potentiallyy positive or negative effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination affect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery is not considered a contributing factor to GOA PSR genetic structure and reproductive success since no bycatch is expected in this fishery to occur. Marine pollution is identified as a potentially adverse contributor to GOA PSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are not considered contributing factors to genetic structure; however, they could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial and temporal characteristics of the GOA PSR complex is possible; however, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability of GOA PSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had positive or negative effects on PSR prey availability (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a potentially adverse contributor to GOA PSR prey availability. The catch of shrimp in the shrimp fishery is expected to continue in the future. Marine pollution is identified as a potentially adverse contributor to PSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability (see Sections 3.5.1.13 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA PSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability of GOA PSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries have been identified as having past persisting negative effects on GOA PSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past positive or negative effects on GOA PSR habitat suitability (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery is not considered a contributing factor to GOA PSR habitat suitability since the gear associated with this fishery is not expected to cause a significant impact to the benthic habitat (see Sections 3.5.1.13 and 3.6). Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could have a potentially beneficial or adverse contribution on DSR habitat suitability (see Sections 3.5.1.13 and 3.10).

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

See Table 4.5-29 for a summary of the cumulative effects on PSR under PA.1 and PA.2.

GOA Demersal Shelf Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for DSR species.

Fishing Mortality

Projected catch of DSR species under PA.1 is expected to increase from the 2002 value of 182 mt to 350 mt in 2003, and is then expected to remain relatively steady throughout 2007. The 2003-2007 average projected catch is 316 mt. PA.2 requires that appropriate harvest strategies be developed for rockfish. If these strategies were to use F_{60}, then projected catch would increase from the 2002 value to 227 mt in 2003, and also remains relatively steady throughout 2007. The 2003-2007 average projected catch under PA.2 is 231 mt.

Under PA.1, there would be few effects on DSR species in the short-term, and overall this management plan would be similar to the FMP 1. As described previously for FMP 1, DSR species are managed conservatively to reduce the risk of overfishing this assemblage. The 2003 OFL has been set at 540 mt (NPFMC 2002a). The 2003 TAC was set equal to the ABC, or 390 mt; so management of DSR in the eastern GOA already complies with this PA.1 requirement. Over the long-term, this FMP would initiate the collection of scientific information necessary to specify a MSST for DSR. Currently DSR fall into Tier 4 and no MSST threshold exists for this species assemblage. Obtaining the information necessary to elevate DSR into a higher Tier and specifying MSST would certainly benefit DSR species and provide opportunities for refining management measures to more fully achieve policy objectives.

DSR species are taken in a small directed fishery with hook and line gear and as bycatch in the halibut longline fishery. Reported catch of DSR has been relatively constant over the last 5 years with landings ranging from 226 mt to 363 mt in large part due to very conservative management practices (Table H.4-74 of Appendix H). Estimated bycatch mortality of DSR in the halibut fishery has ranged about 130 mt to 355 mt annually. A DSR bycatch limit (10 percent) is established during the halibut season to limit mortality of DSR in this fishery. ADF&G requires full retention of DSR in state waters and NPFMC has also recently approved a management measure that requires full retention of DSR species. Once approved by NOAA Fisheries, the measure will improve catch statistics and reduce discards and waste. These measures would continue in PA.1.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future changes in Tier designation for GOA rockfish.

Under PA.1 and PA.2, we expect both the TAC and reported landings to remain stable at present levels. A more precautionary management policy will likely have no significant impact on the ability of DSR to sustain current population levels. Fishing mortality will remain below the OFL under PA.1 and PA.2. Therefore, PA.1 and PA.2 are expected to have insignificant effects on DSR species through mortality.

<u>Spatial/Temporal Concentration of Fishing Mortality</u>

Although management of this assemblage has been conservative, and overall the population appears stable, a decline in the density estimates in the Fairweather Grounds under PA.1 may be an indication that localized overfishing is occurring (O'Connell *et al.* 2002). The TAC for the eastern GOA is partitioned by management district based on biomass density and known habitat. The current harvest strategy indicates that two percent of the exploitable biomass is taken per year and that this level of exploitation is sustainable. However, fishing effort on the Fairweather Grounds appears to be concentrated in areas of best habitat and high density and it may be that local overfishing occurs. The question is whether such potential for localized overfishing would continue under PA.1. The answer is that it could, but the probability is reduced due to the likelihood that TAC will be adjusted downward as better information is obtained on DSR bycatch. Improved scientific information on DSR species would result in improved management that could lead to catch restrictions or other measures designed to prevent localized overfishing. It is presumed that a more precautionary management policy would provide benefits to DSR. As a result, we conclude that PA.1 would generate no significantly adverse impact on DSR stocks.

PA.2 would have a large effect on the spatial and temporal concentration of GOA rockfish catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because PA.2 sets aside 0-20 percent of the GOA as either no-take reserves or as MPAs. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. The rockfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-10 percent in the GOA under PA.2. Hence, if PA.2 were adopted, an indirect effect might be to reduce catches of rockfish if means were not found to control or prevent Pacific halibut bycatch. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

PA.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called race for fish would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

The MSST cannot be determined for this stock complex. One measure in PA.2 that would affect catch of rockfish is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of rockfish, thereby providing even greater protection against overfishing. Continual reduction of TAC in the DSR fishery would be beneficial and likely place DSR as a bycatch-only fishery under PA.2.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA demersal shelf rockfish species. The sex ratio of GOA demersal shelf rockfish species is unknown.

Habitat-Mediated Impacts

Any habitat suitability impacts of PA.1 and PA.2, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient at the present time to conclude that existing habitat suitability indices would undergo any significant change under PA.1. However, PA.1 would initiate a federal MPA program and it is likely that certain areas of the eastern GOA would be candidates for MPA designation. Such a program, by design, could mitigate adverse effects of fishing by protecting areas important to DSR species.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may provide substantial habitat benefits to GOA rockfish.

Predation-Mediated Impacts

As with habitat suitability indices, any effects to predator-prey relationships of PA.1 and PA.2 management would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on DSR under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects**. The effect of fishing mortality on the GOA DSR complex is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering negative effect on the GOA DSR population (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery are not considered to be contributing factors to GOA DSR mortality since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potentially adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not considered to be contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA DSR and is rated as insignificant. DSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effect of the fisheries on the change in biomass level under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering negative effect on the GOA DSR population (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery are not considered to be contributing factors to GOA DSR biomass levels since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potentially adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not considered contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass; however, the effect is unknown since total and spawning biomass levels are currently unavailable.

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA DSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA DSR; however, climate changes and regime shifts have been identified as having had potentially positive or negative effects on DSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination affect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and IPHC longline fisheries are not considered to be contributing factors to GOA DSR genetic structure and reproductive success. Catch/bycatch of these fisheries is already accounted for by the domestic groundfish management or is not expected to occur (as in the case of the State of Alaska herring and shrimp fisheries). Marine pollution is identified as a potentially adverse contributor to GOA DSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are not considered contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial and temporal characteristics of the GOA DSR complex is possible; however, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability of GOA DSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had positive or negative effects on DSR prey availability (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as potentially adverse contributors to GOA DSR prey availability. Catch of herring in the herring fishery and the catch of shrimp in the shrimp fishery are expected to continue in the future. The State of Alaska groundfish fishery and the IPHC longline fishery are not considered to be contributing factors to GOA DSR prey availability since bycatch of DSR prey species in not expected to occur. Marine pollution is identified as a potentially adverse contributor to DSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability (see Sections 3.5.1.13 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability of GOA DSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries and the IPHC longline fisheries have been identified as having past persisting negative effects on GOA DSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past positive or negative effects on GOA DSR habitat suitability (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries are not considered to be contributing factors to GOA DSR habitat suitability since the gear associated with these fisheries is not expected to cause a significant impact to the benthic habitat. The State of Alaska groundfish fisheries and the IPHC longline fisheries are identified as potential adverse contributors to DSR habitat suitability. See Sections 3.5.1.13 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could have a potentially beneficial or adverse contribution to DSR habitat suitability (see Sections 3.5.1.13 and 3.10).

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

See Table 4.5-30 for a summary of the cumulative effects on DSR under PA.1 and PA.2.

4.9.2 Prohibited Species Preferred Alternative Analysis

4.9.2.1 Pacific Halibut

Pacific halibut are managed by the IPHC. Halibut bycatch in federal groundfish fisheries is controlled by the use of PSC limits. IPHC accounts for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery.

Direct/Indirect Effects PA.1 and PA.2 – Pacific Halibut

Direct and indirect effects for Pacific halibut include mortality, and changes in reproductive success and prey availability. These effects, which are associated with changes in catch, are considered insignificant because annual quota setting processes implemented by the IPHC account for all removals of halibut including bycatch in other fisheries. Thus, if changes to the baseline condition of the stock occur, they are reflected in the quotas set for the directed fishery. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of either PA. No evidence of fishery impact to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows. A summary of these effects is shown in Table 4.9-2.

Under PA.1, current halibut PSC caps would be retained with the possibility of future reduction in the BSAI of 0 to 10 percent). Estimated halibut bycatch mortality under PA.1 in the BSAI and GOA combined would decrease slightly from currently observed rates. This decrease would enable a corresponding increase in halibut catch by the IPHC directed fishery. Total removals would continue to be limited by the IPHC to protect the halibut resource.

Under PA.2, current halibut PSC caps in the BSAI would be reduced between 0 and 20 percent with the possibility of also reducing GOA PSC limits by zero to ten percent. Reductions in halibut are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. Estimated bycatch mortality in the BSAI and GOA would decrease, as noted in PA.1, thus enabling directed IPHC fisheries to increase halibut catch rates. Total removals would continue to be limited by the IPHC. In addition, PA.2 proposes the development of inseason closure areas in the GOA once PSC limits have been reached. This measure may provide for additional protection of the halibut resource in areas characterized with significant halibut bycatch.

Cumulative Effects Analysis PA.1 and PA.2 – Pacific Halibut

A summary of the cumulative effects analysis associated with PA.1 and PA.2 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under PA.1 and PA.2 because current management of halibut by the IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect, but is closely managed by the IPHC. Although state-managed fisheries may incidentally catch halibut, the IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate changes and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under PA.1 and PA.2. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of PA.1 and PA.2.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under PA.1 and PA.2. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of PA.1 and PA.2.

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

- **Reasonably Foreseeable Future External Effects.** Halibut are opportunistic predators with a wide range of prey species. An increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate changes and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

4.9.2.2 Pacific Salmon or Steelhead Trout

Pacific salmon are managed by ADF&G, which also manages the salmon sport fisheries and permitted subsistence harvesting, to ensure that escapement goals are met for the spawning population in order to maintain sustained yields from the stock as a whole. Annual harvest levels are responsive to fluctuations in run sizes.

For reasons discussed in Section 4.5.2.2, ESA-listed Pacific Northwest chinook salmon and steelhead trout were not specifically considered in this cumulative effects analysis.

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

A summary of assumptions included in the impact analysis of the proposed FMPs is presented in Section 4.5.2.2.

The cumulative effects analyses were based on two groupings of Alaska salmon in the BSAI and GOA: chinook salmon and other salmon.

Direct/Indirect Effects PA.1 and PA.2 – Chinook and Other Salmon

Direct and indirect effects for chinook salmon and other salmon in the BSAI and GOA include mortality, changes in spawning habitat, prey availability, genetic structure of population, and reproductive success. A summary of these effects is shown in Table 4.9-2.

PA.1 would maintain current PSC limits for salmon in the BSAI with the possibility for reducing them by zero to ten percent in the future. In the GOA, it is proposed that PSC limits, or other appropriate measures, be established for salmon, as well as identifying salmon savings areas to improve management of salmon stocks residing in this region. Under PA.2, BSAI PSC limits for salmon may be further reduced (0 to 20 percent) while considering reduction in GOA PSC limits by zero to ten percent. PA.2 also proposes the development of in-season closures in the GOA to ensure that once PSC limits have been reached, fishing does not continue within that region. These proposed measures may provide additional protection to Alaska salmon stocks, particularly in years of poor runs.

BSAI Chinook Salmon

Under PA.1, chinook salmon bycatch in the BSAI varies, with an average of approximately 25,000 fish over the five-year projection period. Assuming that 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 14,500 to 17,500 fish during the next 6 years. This harvest represents approximately four to six percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Such bycatch levels, which are not detectable in natal streams, would have little or no effect on commercial or subsistence harvests and escapement, and are not expected to significantly impact the sustainability of the stock.

Under PA.2, chinook salmon bycatch in the BSAI varies, with an average of about 20,000 fish over the five-year projection period. In keeping consistent with the assumption in PA.1, the bycatch of western Alaska chinook salmon stocks could range from 11,600 to 14,000 fish during the next six years. This harvest represents approximately three to five percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Reductions in BSAI chinook salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. PA.2 results in a reduction in western Alaska chinook salmon catches; however, such bycatch levels may not be detectable in natal streams, may not exert significant effects on commercial or subsistence harvests or escapement, and may not impact the sustainability of the stock as a whole.

BSAI Other Salmon

Under PA.1, bycatch of other salmon in the BSAI varies averaging 65,000 fish over the projection period. Assuming that 96 percent of other salmon bycatch is chum salmon and 19 percent may be of western Alaska origin, the resulting bycatch of western Alaska chum salmon stocks would be about 12,000 fish over the next 6 years. This harvest represents approximately one percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. It is presumed that these bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests and escapement, and would not significantly impact the sustainability of the stock.

Under PA.2, bycatch of other salmon in the BSAI varies, averaging 54,000 fish over the projection period. Maintaining the distribution assumptions noted in PA.1, the bycatch of western Alaska chum salmon stocks would be approximately 10,000 fish during the next six years. This harvest represents less than one percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. Reductions in BSAI other salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. PA.2 results in bycatch reductions for western Alaska chum salmon catches. However, such bycatch levels may not be detectable in natal streams, may not exert significant effects on commercial or subsistence harvests, or escapement, or significantly impact the sustainability of the stock.

GOA Chinook Salmon

Under PA.1, predicted chinook salmon bycatch in the GOA initially decreases and then gradually increases over the 5-year projection period, reaching similar levels to those observed today (approximately 21,000 fish). Assuming that 58 percent of GOA chinook salmon bycatch is of western Alaska origin, bycatch of western Alaska chinook salmon would average approximately 12,000 fish during the next 6 years. This harvest represents approximately four percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. PA.1 results in reductions of annual western Alaska chinook salmon catch; however, these bycatch levels may not be detectable in natal streams, or exert effects on commercial or subsistence harvests and escapement resulting in significant impacts to sustainability of the stock.

Under PA.2, chinook salmon bycatch in the GOA varies, but remains below those catch rates currently observed (21,000 fish). Thus, chinook salmon bycatch of western Alaska origin is predicted at less than 7,000 fish over the 5-year projection period. This harvest represents less than one percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. PA.2 results in a reduction in western Alaska chinook salmon catch. Reductions in GOA chinook salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. However, significance of these reductions on escapement, commercial or subsistence harvests, and sustainability of the stocks is difficult to determine.

<u>GOA Other Salmon</u>

Under PA.1, bycatch of other salmon in the GOA varies, averaging about 5,000 fish over the 5-year projection period. Assuming that 56 percent of this other salmon bycatch is chum salmon, bycatch would consist of approximately 3,000 chum salmon. The proportion of these fish from western Alaska is unknown. Assuming that all of these fish were from western Alaska, this harvest represents less than one percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. PA.1 reduces western Alaska chum salmon catches. Reductions in GOA other salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. However, the significance of these reductions to escapement, commercial or subsistence harvests, and sustainability of the stock cannot be determined.

Under PA.2, bycatch of other salmon in the GOA varies, but remains similar to those trends noted above for PA.1.

Cumulative Effects Analysis PA.1 – BSAI and GOA Chinook and Other Salmon

A summary of the cumulative effects analysis associated with PA.1 is shown in Tables 4.9-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant under PA.1.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in the BSAI and GOA. Bilateral agreements between the U.S. and these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries, and foreign fisheries while allocating salmon resources to the State of Alaska fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The State of Alaska took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State of Alaska commercial and subsistence fisheries exert effects on mortality of western Alaska chinook and other salmon populations. The magnitude of this effect cannot be determined; however, current stock status indicates that salmon runs in western Alaska are depressed. Taking this stock condition into consideration, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. State of Alaska commercial, subsistence, and sport fisheries also impact salmon populations other than western Alaska chinook. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State of Alaska hatchery enhancement programs initiated in the GOA potentially counteract the effects of mortality on salmon stocks. In addition, long-term climate changes and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook, and BSAI other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for PA.1. Combined bycatch potential in the BSAI and GOA under this FMP could impede the successful recovery of depressed stocks and impact sustainability of the stock as a whole. The combined effects of mortality on GOA other salmon resulting from internal bycatch and future events are considered insignificant under PA.1.

Change in Prey Availability

- **Direct/Indirect Effects**. The potential effects of PA.1 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of salmon prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, a relationship between State of Alaska commercial, subsistence, and GOA sport fisheries bycatch of salmon prey and salmon prey availability has not been defined, and potential effects are unknown. Land management practices are not considered contributing factors in salmon prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State of Alaska hatchery enhancement programs occur in GOA, but do not include prey species of salmon. Long-term climate changes and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

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

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of PA.1 on genetic structure of salmon populations in the BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, salmon bycatch composition has not been determined, so potential effects of State of Alaska commercial, subsistence, and sport fisheries on genetic structure of salmon populations are unknown. For reasons stated above, land management practices, long-term climate changes, and regime shifts are not considered contributing factors to changes in the BSAI and GOA salmon populations. State of Alaska hatchery enhancement programs in the GOA focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in the GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in the BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown under PA.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of PA.1 on reproductive success for BSAI and GOA chinook and other salmon cannot be determined.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska it may be inferred that reproductive success has been impacted in certain populations of the BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach intended spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Stocks in GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State of Alaska commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. Considering the condition of this depressed stock, impacts of catch and bycatch by State of Alaska fisheries could hinder its recovery, and are therefore considered a potential adverse contribution to the population as a whole. GOA other salmon stocks are considered stable, so potential effects of State of Alaska commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for this population. Degradation of watersheds used by spawning salmon, resulting from poor land management practices, could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potential adverse contributions to possible changes in reproductive success of this population. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska, and are considered potentially beneficial to the reproductive success of salmon.

Long-term climate changes and regime shifts could have impacts on the reproductive success of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska, and the combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook, and BSAI other salmon stocks could be impacted. Thus, fisheries catch may remove spawning adults destined for spawning grounds, and potential combined effects from internal and external events are considered conditionally significant adverse to the reproductive success of BSAI and GOA chinook and BSAI other salmon. Although current stock status of GOA chinook and other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from internal bycatch and future external events (both human controlled and natural) cannot be determined for GOA other salmon stocks under PA.1.

Cumulative Effects Analysis PA.2 – BSAI and GOA Chinook and Other Salmon

A summary of the cumulative effects analysis associated with PA.2 is shown in Table 4.9-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant under PA.2.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in the BSAI and GOA. U.S. bilateral agreements between the U.S. and these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the State of Alaska fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The State of Alaska took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects**. External effects on Alaskan salmon populations differ between the BSAI and GOA and will be discussed independently for each region.

  In the BSAI, State of Alaska commercial and subsistence fisheries exert effects on mortality of chinook and other salmon populations. The magnitude of this effect cannot be determined; however, current stock status indicates that salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by State of Alaska fisheries could hinder recovery of depressed stocks, and are considered a potential adverse contribution to the population as a whole. In the GOA, State of Alaska commercial, subsistence, and sport fisheries exert effects on mortality of other salmon populations due to their stability. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State of Alaska commercial enhancement programs were initiated in the GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate changes and regime shifts are not expected to result in direct mortality of salmon.

  In the GOA, State of Alaska commercial, subsistence, and sport fisheries exert effects on mortality of chinook and other salmon populations. However, they are not expected to impact salmon stocks in this region under PA.2. As mentioned in the BSAI above, land management practices are an important factor influencing spawning habitat of salmon, but are not considered contributing factors in direct mortality of salmon in the GOA. State of Alaska commercial enhancement programs were initiated in the GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. Long-term climate changes and regime shifts are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on the BSAI and GOA chinook and BSAI other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for PA.2. Combined bycatch potential of the BSAI and GOA under this FMP could impede on the successful recovery of depressed stocks in the BSAI and impact sustainability of the stock as a whole. The combined effects of mortality on GOA other salmon resulting from bycatch and future events are considered insignificant under PA.2.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects**. The potential effects of PA.2 on prey availability for BSAI and GOA and other salmon are unknown. A relationship between fisheries bycatch of salmon prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, a relationship between State of Alaska commercial, subsistence, and GOA sport fisheries bycatch of prey and salmon prey availability has not been defined, and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. Long-term climate changes and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment, while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time. State of Alaska hatchery enhancement programs that occur in the GOA do not include prey species of salmon.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown under PA.2.

<u>Change in Genetic Structure of Population</u>

- **Direct/Indirect Effects.** The potential effects of PA.2 on genetic structure of salmon populations in the BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects**. In both the BSAI and GOA, salmon bycatch composition has not been determined, so potential effects of State of Alaska commercial and subsistence fisheries on genetic structure of salmon populations are unknown. Significant impacts to genetic structure of salmon populations by land management practices are not expected, and are not considered contributing factors to a possible change in baseline condition. Long-term climate changes and regime shifts are not expected to result in direct mortality, which would potentially affect genetic structure of BSAI and GOA chinook and other salmon stocks. State of Alaska hatchery enhancement programs in the GOA focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in the GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in the BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown under PA.2.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of PA.2 on reproductive success for BSAI and GOA chinook and other salmon cannot be determined.

- **Persistent Past Effects**. Given the poor stock status of salmon runs in western Alaska it may be inferred that reproductive success has been impacted in certain populations of the BSAI region.

Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Stocks in the GOA are currently considered stable so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** External effects on Alaskan salmon populations differ between BSAI and GOA and will be discussed independently for each region.

  In the BSAI, State of Alaska commercial and subsistence fisheries catch of chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of catch and bycatch by State of Alaska fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Degradation of watersheds used by spawning salmon, and caused by poor land management practices, could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potential adverse contributions to possible changes in reproductive success of this population.

  Salmon stocks in the GOA are considered stable, so potential effects of State of Alaska commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for this population. For reasons stated above, land management practices are considered as potential adverse contributions to the reproductive success of the GOA salmon stocks. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska and are considered potentially beneficial to the reproductive success of salmon.

  Long-term climate changes and regime shifts could have impacts on the reproductive success of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential of the BSAI and GOA, the sustainability of BSAI and GOA chinook and BSAI other salmon stocks could be impacted. Thus, fisheries catch may remove spawning adults destined for spawning grounds. Potential combined effects from internal and external events is considered conditionally significant adverse to the reproductive success of BSAI and GOA chinook and BSAI other salmon. Although current stock status of GOA chinook and other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from internal catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA other salmon stocks under PA.2.

4.9.2.3 Pacific Herring

Pacific herring are managed by ADF&G. Harvest policy and allocations among gear (user) groups are established by the Alaska Board of Fisheries. Annual harvest quotas are set by ADF&G under an exploitation rate harvest policy; herring exploitation rates are capped at a maximum level of 20 percent statewide. All directed herring fisheries occur in State of Alaska waters, and are managed by regulatory stocks.

A detailed discussion of the modeling approach used in this analysis is included in Section 4.5.2.3. Given the low herring bycatch levels that are predicted across all proposed FMPs, bycatch removals would not be expected to have significantly different impacts on herring abundance estimates between FMPs.

Direct/Indirect Effects PA.1 and PA.2 – Pacific Herring

Direct and indirect effects for Pacific herring include mortality changes in reproductive success, prey availability, and habitat. These effects, which are associated with changes in catch, are considered insignificant because annual quota setting processes implemented by ADF&G are responsive to fluctuations in herring biomass. A summary of these effects is shown in Table 4.9-2.

Under PA.1, current herring PSC caps would be retained with the possibility of future reduction in the BSAI (0 to 10 percent). Total removals would continue to be limited by ADF&G to protect the herring resource.

Under PA.2, current herring PSC caps in the BSAI would be reduced between 0 and 20 percent with the possibility of also reducing GOA PSC limits by 0 to 10 percent . Total removals would continue to be limited by ADF&G. In addition, PA.2 proposes the development of inseason closure areas in the GOA once PSC limits have been reached. This measure may provide for additional protection of the herring resource in areas characterized with significant herring bycatch.

Cumulative Effects Analysis PA.1 and PA.2 – Pacific Herring

A summary of the cumulative effects analysis associated with PA.1 and PA.2 is shown in Table 4.5-34. For further information on persistent past effects included in this analysis, see Section 3.5.2.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects**. The potential effect of fishing mortality on BSAI and GOA herring is insignificant under PA.1 and PA.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass. The herring savings areas reduce herring bycatch potential by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s, with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have had long-term impacts on impacted herring populations long-term. In addition, past federal groundfish fisheries bycatch, combined with the directed State of Alaska fisheries, have exceeded the State of Alaska's herring harvest policy and may still exert lingering effects on current herring populations in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Directed State of Alaska herring fisheries still occur, but are closely managed by ADF&G. Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. State of Alaska subsistence catch is also accounted for in ADF&G herring management plans. These fisheries are not considered contributing factors to changes in herring mortality. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring mortality, especially for those populations that are still recovering from the EVOS in the GOA. Long-term climate changes and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass. Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. Thus, although some persistent past effects may still be present on certain herring populations in the BSAI and GOA, the combined effects of mortality on Pacific herring resulting from bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under PA.1 and PA.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in reproductive success occurs, it would most likely be reflected in corresponding changes to biomass, which are incorporated into ADF&G management plans for Pacific herring.

- **Persistent Past Effects**. As discussed in the analysis of cumulative effects on Pacific herring mortality, years of unregulated foreign harvest and past federal groundfish fisheries bycatch that exceeded the State of Alaska's herring harvest policy may still exert lingering effects on current herring populations in the BSAI and GOA. Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. It has been found that this type of contamination exposure to adult and larval herring can result in many adverse effects such as: increased rates of egg mortality, larval deformities, and immune system deficiencies. It is presumed that the effects of EVOS still exist, and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** Directed State of Alaska herring fisheries still occur, but are closely managed by the ADF&G. Fishing quotas are based on variable exploitation rates that account for declines in stock. State subsistence fisheries catch is accounted for in ADF&G herring management plans. Thus, these fisheries are not considered contributing factors to changes in herring reproductive success. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring reproductive success, especially for those populations that are still recovering from the EVOS in the GOA. Long-term climate changes and regime shifts could have impacts to the reproductive success of Pacific herring depending on the direction of the shift.

It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass and fishing quotas are based on variable exploitation rates that account for declines in herring stock. Although certain herring populations in the GOA have been impacted by EVOS, the stock as a whole is considered recovering. Thus, some persistent past effects may still be present on certain herring populations in the BSAI and GOA, but the combined effects on Pacific herring reproductive success resulting from bycatch and future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

Change in Prey Availability

- **Direct/Indirect Effects**. The potential effect of federal groundfish fisheries on prey availability for BSAI and GOA herring is insignificant under PA.1 and PA.2 because current management by ADF&G is responsive to fluctuations in herring biomass regardless of the cause associated with the change. Thus, if a change in prey availability did occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans for Pacific herring.

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

- **Reasonably Foreseeable Future External Effects**. Pacific herring feed primarily on zooplankton which are not affected by State of Alaska directed herring fisheries or State of Alaska subsistence fisheries. Thus, these fisheries are not considered contributing factors to changes in prey availability for herring. Future acute and chronic marine pollution could occur, but effects on prey such as zooplankton, are unknown. Long-term climate changes and regime shifts could have impacts too many species that contribute to the prey structure of Pacific herring. The nature of these impacts depends on the direction of the climatic shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** Potential effects of future natural events, such as marine pollution and climatic shifts, on prey availability for Pacific herring are unknown for PA.1 and PA.2.

Change in Habitat

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under PA.1 and PA.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in important habitat occurs, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans for Pacific herring. The herring savings areas reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. The long-term effects of this event to herring habitat are unknown. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** No evidence of fishery impacts on habitat of herring exists. Thus, fisheries are not considered contributing factors to changes in herring habitat at this time. Future acute and chronic marine pollution could occur and is considered potentially adverse to some herring habitat, especially those that are still recovering from EVOS in the GOA. Long-term climate changes and regime shifts are not expected to significantly change physical habitat of Pacific herring.

- **Cumulative Effects.** Potential impacts of future natural events, such as marine pollution and climatic shifts, in addition to lingering contamination from EVOS on certain habitat of herring in the GOA exist, but effects are not known for PA.1 and PA.2.

4.9.2.4 Crab

Alaska king, bairdi Tanner crab, and opilio Tanner crab (also called snow crab) fisheries are managed by the State of Alaska, with federal oversight and guidelines established in the BSAI king and Tanner crab FMP (NPFMC 1989). Section 4.5.2.4 contains further information on current stock status and management of crab in Alaska.

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

Direct/Indirect Effects PA.1 and PA.2 – Crab

Direct and indirect effects for all species of crab in the BSAI and GOA include mortality, changes in biomass, reproductive success, prey availability, and habitat. These effects may be attributed to fishing activities (both directed fishing and bycatch), but may also be linked to natural events such as long-term climatic changes and decadal regime shifts. Significance of these effects is based on the likelihood that population-level changes will result from internal events within the groundfish fishery. An effect that is considered insignificant corresponds to a change that is not likely to result in population-level effects on crab or that lies within the range of natural variability for the species.

Under PA.1, all existing closures/restricted areas (i.e., Red King Crab Area and Pribilof Island closures) will be maintained, as will the 2002 Steller sea lion closures. In addition, identification and designation of EFH and HAPC is proposed. Current PSC limits for crab in the BSAI will be maintained under PA.1 with consideration for further reduction by zero to ten percent. PSC limits, or other appropriate measures, will be established for crab in the GOA and based on biomass estimates or other fishery data.

PA.2 includes and builds upon the proposed measures in PA.1. In addition to maintaining existing closure areas, review of these closures to determine if they qualify as MPAs, including no-take reserves, has been suggested. Other proposed measures under PA.2 include: implementation of mitigation measures for EFH and HAPC that show significantly adverse effects from fishing, establishing an Aleutian Islands management area to protect living habitat (often contained in crab habitat), possible modification to Steller sea lion closures (including Aleutian Islands) with designation of critical habitat based on scientific data, and development of inseason closure areas in the GOA triggered by PSC limits being reached. Also proposed under PA.2 is a further reduction in the BSAI crab PSC limits by 0 to 20 percent and GOA limits by zero to ten percent. Expansion of observer coverage based on scientific data and compliance needs for all vessels is also included in PA.2. This observer coverage, along with improved species identification for non-target species, may provide additional protection to crab populations throughout the BSAI and GOA regions and provide for more reliable crab bycatch composition data.

Cumulative Effects Analysis PA.1 and PA.2 – Crab

Summaries of the cumulative effects analyses associated with PA.1 and PA.2 are shown in Table 4.9-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.4 of this Programmatic SEIS.

The foundation of the cumulative effects analysis is the baseline description for each species that includes population status and trends, if known, and the major human and natural influences that have affected the population in the past and that continue up to the present.

For each species, the predicted direct and indirect effects of the groundfish fishery are then analyzed for their contribution to the overall impacts from all sources, including reasonably foreseeable future events resulting from human and natural events external to the fishery. The reasonably foreseeable future events also include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are each rated according to the same significance criteria as the direct/indirect effects of the fishery and are based on the potential for population-level effects.

<u>Mortality</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in the BSAI

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of these crab species does not reflect large deviations from the current baseline condition, however, catch trends do vary throughout the five-year period. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed, and in some instances, overfished. Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs. Furthermore, additional protection measures could enhance habitat and possible recovery of depressed stocks, but these changes are not expected to significantly affect the crab population in the BSAI as a whole. Under PA.1 and PA.2, it is possible that bycatch of crab could decrease, and additional protection measures could enhance habitat and possible recovery of depressed stocks, but these changes are not expected to significantly affect the crab populations in the BSAI as a whole. Thus, PA.1 and PA.2 are considered to have insignificant effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI because no sign of recovery for these stocks has been shown to date.

- **Persistent Past Effects**. Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The United States initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between State of Alaska crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, managed by ADF&G in cooperation with NOAA Fisheries. These fisheries are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI since no signs of recovery have been shown. Formal stock rebuilding plans are in place for the BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. The BSAI red king crab stocks do not have rebuilding plans in effect, and the populations are currently considered depressed. Long-term climate changes and regime shifts are not expected to result in direct mortality of crab stocks, and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. It is unclear if additional protection measures and decreased bycatch of crab will mitigate the combined effects of mortality resulting from past events, internal bycatch, and reasonably foreseeable future external events on depressed stocks. Thus, cumulative effects of PA.1 and PA.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in the BSAI and GOA

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of golden king crab in the BSAI and GOA were combined with predictions for blue king crab. The BSAI predictions showed increases in catch for PA.1 and decreases in catch for PA.2 over the next five years when compared to current catch rates. Model projections for GOA catch showed decreases in catch for PA.1 and PA.2 compared to current catch in this region. Crab bycatch could decrease as a result of bycatch reduction incentives built into rationalization programs. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of PA.1 and PA.2 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects**. Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist (see the previous discussion of persistent past effects on crab in the BSAI).

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab fisheries, scallop fisheries, and subsistence fisheries continue to occur, managed by ADF&G in cooperation with NOAA Fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in the BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate changes and regime shifts are not expected to result in direct mortality of crab stocks, and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects**. ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other State of Alaska and federal fisheries. Under PA.1 and PA.2, it is possible that bycatch of golden king crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in the BSAI and GOA is unknown. Thus, potential combined effects of mortality, resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time.

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of bairdi Tanner, red king, and blue king crab in the GOA showed decreases from current baseline for the next 5 years. Under these proposed FMPs, it is expected that bycatch of bairdi Tanner, red king, and blue king crab in the GOA crab could decrease, likely as a result of bycatch reduction incentives built into rationalization programs.

  However, significance of these predicted changes in catch on mortality is unknown for bairdi Tanner and blue king crab due to lack of survey information for determining current stock status as a whole. Thus, effects of PA.1 and PA.2 on mortality of GOA bairdi Tanner and blue king crab are unknown. GOA red king crab stocks are considered severely depressed according to ADF&G survey information, but it is unclear if possible decreases in crab catch proposed under the PA will mitigate driving factors of mortality in these stocks. PA.1 and PA.2 are considered insignificant for mortality effects on GOA red king crab populations due to the lack of recovery that has been observed in these stocks to date.

- **Persistent Past Effects**. Adverse past effects of mortality on GOA crab stocks from directed crab catch and bycatch could still exist (see previous section of persistent past effects on GOA crab).

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in the GOA is currently unknown. Thus, the potential effects of these fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with State of Alaska fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in the GOA. Long-term climate changes and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed but their overall stock status is unknown. Thus, potential combined effects of mortality resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time. It is unclear if additional protection measures and decreased bycatch of crab put forth under the PA will mitigate the combined effects of mortality, resulting from past events, internal bycatch, and reasonably foreseeable future external events on severely depressed red king crab stocks. Cumulative effects of PA.1 and PA.2 on GOA red king crab cannot be determined at this time.

Change in Biomass

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in the BSAI

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of these crab species do not reflect large deviations from the current baseline condition, although catch trends vary throughout the five-year period. Under the PA, it is possible that bycatch of crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs, but these changes are not expected to significantly affect crab biomass in the BSAI as a whole. Thus, PA.1 and PA.2 are considered to have insignificant effects on changes in biomass of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist (see previous discussion of persistent past effects on crab).

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur and are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. The BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Potential effects of long-term climate changes and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. It is unclear if additional protection measures and decreased bycatch of crab will mitigate the combined effects of mortality and subsequent changes to biomass resulting from past events, internal bycatch, and reasonably foreseeable future external events on depressed stocks. Thus, cumulative effects of PA.1 and PA.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in the BSAI and GOA

- **Direct/Indirect Effects**. Due to lack of survey information for determining current biomass of golden king crab in the BSAI and GOA, potential effects of PA.1 and PA.2 on changes to biomass cannot be determined.

- **Persistent Past Effects**. The potential effects of past fishing mortality on biomass of golden king crab stocks in the BSAI and GOA cannot be determined because catch composition is unknown and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab. However, the overall stock status of golden king crab stocks in the BSAI and GOA is unknown, and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Effects of long- term climate changes and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Under the PA, it is possible that bycatch of golden king crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. However, persistent past effects on these crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status and biomass estimates of golden king crab in the BSAI and GOA are unknown. Thus, potential combined effects of changes in biomass resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time.

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of bairdi Tanner, red king, and blue king crab in GOA shows decreases from currently observed catch over the next five years. Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs. However, significance of these predicted changes in catch on the change in biomass mortality is unknown for bairdi Tanner and blue king crab due to lack of survey information for determining current stock status as a whole. Thus, effects of PA.1 and PA.2 on biomass of GOA bairdi Tanner and blue king crab are unknown. GOA red king crab stocks are considered severely depressed according to ADF&G survey information, but it is unclear if possible decreases in crab catch proposed under these FMPs will mitigate driving factors of mortality in these stocks. PA.1 and PA.2 are considered insignificant to potential changes in biomass for GOA red king crab populations due to the lack of recovery that has been observed in these stocks to date.

- **Persistent Past Effects**. Adverse effects of past fishing mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in GOA may still exist as recovery of depressed stocks has not been observed.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with State of Alaska fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Effects of long-term climate changes and regime shifts of crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other State of Alaska and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in the GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status and biomass estimates are unknown. Thus, potential combined effects of changes in biomass, resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time. It is unclear if additional protection measures and decreased bycatch of crab put forth under the PA will mitigate the combined effects of mortality and corresponding changes to biomass resulting from past events, internal bycatch, and reasonably foreseeable future external events on severely depressed red king crab stocks. Therefore, the cumulative effects on GOA red king crab cannot be determined at this time.

<u>Change in Reproductive Success</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in the BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. Changes in reproductive success within the BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causal link between reproductive success and depressed stock status cannot be concluded at this time. Potential effects of PA.1 and PA.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects**. As discussed earlier, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set to avoid mating and molting periods therefore, these fisheries are not considered to be contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI. Formal stock rebuilding plans are in place for the BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on the recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. The potential effects of long-term climate changes and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods; however, persistent past effects on crab populations in the BSAI may still exist. Stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success, resulting from past events, internal catch and internal bycatch, and reasonably foreseeable future external events, are unknown for PA.1 and PA.2.

Golden King Crab in the BSAI and GOA

- **Direct/Indirect Effects**. Due to lack of survey information for determining current stock status of golden king crab in the BSAI and GOA, potential effects of PA.1 and PA.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects**. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods therefore, these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate changes and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success resulting from past events, internal bycatch, and reasonably foreseeable future external events, are unknown for PA.1 and PA.2.

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in the GOA, potential effects of PA.1 and PA.2 on changes to reproductive success cannot be determined. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery, while other GOA stocks are still considered depressed. Red king crab populations in the GOA are at historic lows according to ADF&G survey information. Changes in reproductive success within the GOA crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causal link between reproductive success and depressed stock status cannot be concluded at this time. Potential effects of this PA on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in the GOA.

- **Persistent Past Effects**. As discussed earlier, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Crab seasons are set to avoid mating and molting periods; therefore, these fisheries are not considered contributing factors to changes in the reproductive success of these stocks. The potential effects of long-term climate changes and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the GOA may still exist. Some stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success resulting from past events, internal catch/internal bycatch, and reasonably foreseeable future external events, are unknown for PA.1 and PA.2.

Change in Prey Availability

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, only BSAI opilio Tanner crab is included in this analysis.

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and it is unclear if PA.1 and PA.2 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of the PA on changes in prey availability cannot be determined.

- **Persistent Past Effects**. Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past groundfish fisheries is minimal. Thus, past effects on crab prey structure and availability in the BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and these fisheries are not considered contributing factors to changes in prey availability. Rebuilding plans currently in effect in the BSAI do not address crab prey structure and availability and are not considered contributing factors to potential changes in prey availability. Long-term climate changes and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the possible effects that these changes may have on crab populations throughout the BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined, and potential changes to prey structure, resulting from internal effects and reasonably foreseeable future events, cannot be determined for all species of crab in the BSAI and GOA for PA.1 and PA.2.

Change in Habitat

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in the BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. However, a direct causal link between habitat and depressed stock status cannot be concluded at this time. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, but recovery has not been shown. Under PA.1 and PA.2, it is possible that additional protection measures could enhance recovery of crab habitat, but it is impossible to realize the potential population-level effects that may result. Thus, PA.1 and PA.2 are considered to have insignificant effects on changes in habitat of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist, as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time and offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed with possible habitat- related effects unclear. Long-term climate changes and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures or those proposed under the PA. Thus, potential effects on crab habitat, resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined.

Golden King Crab in the BSAI and GOA

- **Direct/Indirect Effects**. Due to lack of survey information for determining current stock status of golden king crab in the BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout the BSAI and GOA. Potential effects of PA.1 and PA.2 to crab habitat are unknown.

- **Persistent Past Effects**. As discussed in the analysis of cumulative effects on mortality of Bairdi tanner, Opilio tanner, red king and blue king crab, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as many of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans, and the current depressed nature of some golden king crab stocks in the GOA. Long-term climate changes and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Some GOA golden king crab stocks are considered depressed, and past effects may still exist as many of these stocks have not shown signs of recovery to date. Although much of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation areas, it is possible that other critical habitat areas are not included in these measures or those proposed under the PA. Thus, potential effects on golden king crab habitat resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined without first establishing the overall population and essential habitat status of this species.

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Red king and bairdi Tanner stocks in the GOA are currently considered depressed, while blue king crab stock status is unknown. Data on bairdi Tanner crab is limited, but stocks are presumed to be depressed based on available survey data. The red king crab stocks are considered severely depressed according to ADF&G surveys. However, a direct causal link between habitat and depressed stock status cannot be concluded at this time. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, but recovery of stocks has not been shown. Under PA.1 and PA.2, it is possible that additional protection measures could enhance recovery of crab habitat, but it is impossible to realize the potential population-level effects that may result. Thus, PA.1 and PA.2 are considered to have insignificant effects on changes in habitat of red king crab stocks in the GOA because no signs of recovery for these stocks have been shown to date. Thus, the cumulative effects on habitat suitability for these stocks cannot be determined. Under the PA, it is possible that additional protection measures could enhance recovery of crab habitat, but it is impossible to realize the potential population-level effects that may result. Thus, the potential effects of PA.1 and PA.2 on changes to bairdi Tanner, red king, and blue king crab habitat in the GOA are unknown.

- **Persistent Past Effects.** Past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date (see previous discussions of persistent past effects).

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for some of these stocks under current management plans. Long-term climate changes and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist, and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of GOA crab are currently protected by no trawl zones and conservation areas, it is possible that other critical habitat areas are not included in these measures, nor those proposed under this PA. Thus, potential cumulative effects on GOA bairdi Tanner, red king, and blue king crab habitat resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined.

4.9.3 Other Species Preferred Alternative Analysis

The other species category consists of the following species:

- Squid (order Teuthoidea).

- Sculpin (family Cottidae).

- Shark (Somniosus pacificus, Squalus acanthias, Lamna ditropis).

- Skate (genera Bathyraja and Raja).

- Octopi (*Ocotopus dofleini*, *Opistholeutis california*, and *Octopus leioderma*).

Current management practices provide for the establishment of an aggregate TAC, which limits the catch of species in this category. Within the other species category, only shark are identified to the species level by fishery observers. Furthermore, accuracy of catch estimates depends on the level of coverage in each fishery. Observer coverage in the BSAI is estimated at 70-80 percent, whereas the GOA has approximately 30 percent observer coverage. Coverage can vary for certain target fisheries and vessel sizes (Gaichas 2002). Further description of this management of the Other Species category is described in detail in Section 3.5.3.

Formal stock assessments for other species are not currently conducted in the BSAI and GOA, and biomass estimates for the species included in this category are limited and often unreliable. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to the lack of information needed to establish the baseline condition. While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact other species populations, or whether these impacts might be beneficial, adverse, or insignificant. There are numerous direct and indirect effects that may impact the current and future status of individual species within this group and/or this group as a whole. These effects are summarized in the section that follows.

Direct/Indirect Effects PA.1 – Other Species

Direct and indirect effects for other species include mortality, changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of the non-target species groups are unknown. In order to determine how these stocks respond to changes in catch, information on stock status is needed. For many non-target species, the differences in catch between the comparative baseline and the proposed alternatives are relatively small, such that diverse FMPs may have similar (unknown) effects on each stock. A summary of these effects is shown in Table 4.9-2.

Under PA.1, total catch of BSAI and GOA other species is predicted to increase by several thousand mt per year. This is due to predicted increases in catches in the target fisheries where other species are caught as bycatch. Most of this increase is predicted in the catch of skate and sculpin in both areas. Catch projections for specific groups within the BSAI and GOA other species are presented below.

<u>Squid</u>

In the BSAI, squid catch is predicted to increase and then decrease to just above the current level over the five-year projection, likely following trends in the pollock fishery. Squid catch is predicted to double over the five-year projection period in the GOA, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so doubling may not cause different population impacts than current catch levels.

<u>Sculpin</u>

Catches of BSAI sculpin are predicted to remain very close to currently observed catches. GOA sculpin catch is predicted to increase slightly from current catch amounts, but the significance of this change cannot be determined.

<u>Shark</u>

BSAI and GOA shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of all of these species in the BSAI are predicted to remain stable throughout the projection period under PA.1. All shark catch in the GOA is predicted to be relatively low, and catches of other shark remain close to current catch levels. Pacific sleeper shark catch is predicted to decrease to about one-third of current catch levels and then slowly increase over the five-year projection period to levels just below those observed currently. Salmon shark catch is predicted to decrease slightly. Catch of dogfish in the GOA is predicted to gradually increase over the five-year projection period showing an average increase of more than 50 percent compared to current catch levels.

Skate

The increased catch of skate in the BSAI may reflect increased catches in both longline fisheries for Pacific cod and in bottom trawl fisheries for cod and flatfish. In the GOA, skate catch is predicted to increase by about 1,000 mt. These increases in catch rates for BSAI and GOA may warrant increased management attention if they actually were to occur.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the Target Species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined Big and Longnose skates in the Central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway, and improved collection of data is expected under this amendment.

Octopi

Octopi catch in the BSAI is predicted to remain stable at 300 to 400 mt per year. The trace amounts of octopi catch reported in the GOA are predicted to decrease over the projection period, with no discernable differences in the currently unknown population impacts.

Direct/Indirect Effects PA.2 – Other Species

A summary of the direct and indirect effects associated with PA.2 is shown in Table 4.9-2.

Under PA.2, total catch of BSAI other species is predicted to decrease by several thousand mt per year, and total catch of GOA other species is predicted to remain in a similar range to current levels,. This is due to predicted decreases in catches of target species where other species are bycatch. Most of the decrease in the BSAI is predicted in the catch of skate and sculpin. Catch projections for specific groups within the BSAI and GOA other species are presented below.

Under PA.2, it is proposed that criteria be developed for applying TAC-setting procedures to specific species groups within the other species category. Sharks and skates have been the focus of this effort, but other species may be added as population data becomes available. By implementing specific TAC-setting measures into species classes that have traditionally been included in the overall other species TAC, improved management of these individual species may minimize potential population-level impacts resulting from bycatch mortality. In addition, improved observer coverage and species identification for non-target species, as proposed in PA.2, may provide improved bycatch data further supporting the need for more comprehensive management of particular species within the other species complex.

Squid

In the BSAI, squid catch is predicted to decrease slightly below the current level over the five-year projection, likely following trends in the pollock fishery. GOA squid catch is predicted to remain within the same range as current catches over the first few years of the projection period with a gradual increase thereafter, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so this increase may not result in significant population-level impacts.

Sculpin

Catches of BSAI sculpin are predicted to decrease slightly by 1,000 mt relative to current catches. The decreased catch of sculpin are due primarily to bycatch reduction incentives included in rationalization programs under PA.2. GOA sculpin catch is predicted to increase slightly each year throughout the five-year projection period, but averages a level similar to currently observed levels over time.

Shark

BSAI and GOA shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Under PA.2, BSAI shark catch for all species remains relatively similar to those levels currently observed. GOA salmon shark are predicted to experience a decrease in catch over the five-year projection period by approximately 40 percent of currently observed levels. On average, GOA Pacific sleeper sharks show a decrease in catch by approximately 50 percent of current catch levels throughout the five-year projection period. Projected dogfish catch levels in the GOA remain similar to current levels.

Skate

The catch of BSAI skate is predicted to decrease by nearly 3,000 mt to about 15,500 mt over the projection period under PA.2. The decreased catch of skate is due primarily to bycatch reduction incentives included in rationalization programs under PA.2. This decrease in catch of skate may reflect decreased catches in both longline fisheries for Pacific cod and in bottom trawl fisheries for cod and flatfish. In the GOA, skate catch is predicted to remain close to currently observed levels.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the Target Species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined Big and Longnose skates in the Central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

Octopi

Octopi catch in the BSAI is predicted to remain stable at 200 to 300 mt per year. The trace amounts of octopi catch reported in the GOA are predicted to decrease over the five-year projection period by approximately 25 percent on average.

Cumulative Effects Analysis PA.2 – Other Species

A summary of the cumulative effects analysis associated with PA.1 and PA.2 is shown in Table 4.5-81. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under PA.1 and PA.2. The current baseline condition is unknown. Species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries.

- **Persistent Past Effects**. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific-species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate changes and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects**. For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA other species are unknown under PA.1 and PA.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects**. Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species, other species, and non-specified species, are within the categories receiving the least intensive management under the current FMP. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered, or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since the current baseline condition and species-specific reproductive status have not been determined. Long-term climate changes and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species within this complex are unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in the BSAI and GOA are unknown under PA.1 and PA.2. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects**. The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP (i.e. other species and non- specified species). This possible overexploitation could have impacts to the genetic structure of the population if the genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to the genetic structure of the specific species populations within this complex are unknown. Long-term climate changes and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects**. For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under PA.1 and PA.2. The current baseline condition is unknown and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries. Formal stock assessments are not conducted for other species, and most biomass estimates for BSAI and GOA other species are unreliable or not known.

- **Persistent Past Effects**. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species, other species, and non-specified species are within the categories receiving the least intensive management under the current FMP. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fisheries continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown since the current baseline condition has not been determined. Long-term climate changes and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects**. For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species is unknown under PA.1 and PA.2. A current baseline condition has not been determined.

- **Persistent Past Effects**. Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fisheries continue to take other species as bycatch. However, potential impacts to the habitat of the specific species within this complex are unknown. Long-term climate changes and regime shifts are not expected to result in significant changes to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects**. For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

4.9.4 Forage Fish Preferred Alternative Analysis

The BSAI and GOA FMPs were amended in 1998 to establishing a forage species category to prevent the development of directed fisheries on these ecologically important non-target species. Forage fish are described in more detail in Section 3.5.4.

Direct/Indirect Effects of PA.1 and PA.2 – BSAI and GOA Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The incidental catch rates predicted for PA.1 and PA.2 are not expected to affect biomass.

Catch/Fishing Mortality

A directed fishery on forage species is prohibited by Amendments 36 and 39 in the BSAI and GOA FMPs. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (>90 percent most years) of the forage fish bycatch is made up of smelt species (Osmeridae) from the pollock fishery. In the BSAI region, model projections for PA.1 and PA.2 indicate incidental catch of forage fish would remain low at a level similar to the current catch (Table H.4-63 in Appendix H). Over the next five years, pollock catch in the GOA is projected to grow rapidly under PA.1 and PA.2 (Table H.4-82 in Appendix H). The increased pollock catch under these FMPs is projected to result in greater incidental catches of forage fish.

Fishing mortality of BSAI and GOA forage fish is unknown at this time. As described above, forage fish bycatch and fishing mortality in the BSAI is predicted to remain relatively low under PA.1 and PA.2. The predicted increase in forage fish bycatch in the GOA would intuitively lead to an increase in fishing mortality. However, since the fishing mortality is currently thought to be very low, there is no evidence that this increase will lead to an adverse affect on the population.

Under PA.1, NOAA Fisheries and NPFMC will initiate a cumulative effects study to determine the impacts of reopening the Aleutian Islands pollock fishery on Steller sea lions and other members of the BSAI ecosystem. If the Aleutian Islands fishery were to be reopened at the conclusion of the study, this would likely increase the bycatch of forage fish.

Measures that may reduce forage fish mortality under PA.1 include reduced PSC limits in the BSAI (0 to 10 percent) and 2002 Steller sea lion measures, which may further restrict the target fisheries (discussed under change in habitat suitability). Under PA.2, PSC limits could be further reduced in the BSAI (0 to 20 percent) and GOA (0 to 10 percent). The 2002 Steller sea lion measures would be adopted and the Aleutian Islands closures, and critical habitat designations could be revised, as necessary. Furthermore, under PA.2, 0 to 20 percent of the Bering Sea and Aleutian Islands and GOA would be designated as MPAs or no-take reserves. In the GOA, inseason bycatch closures would be developed, and the effectiveness of current closures would be reevaluated in the BSAI. Also, the BSAI pollock bottom trawl closures would be extended throughout the GOA.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality in forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under PA.1. The existing closure areas will remain under PA.1; therefore, bycatch of forage species is unlikely to change substantially with regards to spatial concentration. Increased PSC limits for the BSAI fisheries may affect the temporal concentration of forage fish bycatch, although the impact is expected to be minimal. Under PA.2, reduced PSC limits and an increased number of closure areas may affect the spatial and temporal characteristics of forage fish bycatch; however, the impact of these changes are unknown.

Status Determination

The MSST of forage fish species is unknown at this time, but it is highly unlikely that management practices under PA.1 and PA.2 would lead to stocks declining to an unsustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of species in the forage fish group is unknown. However, it is assumed that the age and size composition of forage fish would not change under PA.1. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest a potential change under PA.1.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the habitat occupied by forage fish. The 2002 Steller sea lion closures prohibit fishing in Seguam Pass, establishes three nm no-transit zones around rookeries, and establishes trawl and fixed gear closures in nearshore and critical habitat areas. Programs to identify and designate EFH and HAPC will continue under PA.1, and mitigation measures for EFH and HAPC would be developed under PA.2. As mentioned above, under PA.2, 0 to 20 percent of the Bering Sea, Aleutian Islands and GOA could be established as MPAs and no-take reserves. These measures may reduce the potential adverse impacts to BSAI and GOA forage fish habitat where overlap with fisheries occurs.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the available data, it would be extremely difficult to accurately assess the predator-prey impacts of PA.1.

See Table 4.9-2 for a summary of the direct/indirect effects on BSAI and GOA forage fish under PA.1.

Cumulative Effects Analysis of PA.1 and PA.2 – BSAI and GOA Forage Fish

Mortality

- **Direct/Indirect Effects**. The effect of fishing mortality on BSAI and GOA forage fish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI or GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on mortality are indicated due to potential adverse contributions of marine pollution, since acute and/or chronic pollution events could result in forage fish mortality. Climate change and regime shifts are considered non-contributing factors, since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of forage fish (see Sections 3.5.4 and 3.10). Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish mortality, however, the removal of these fisheries is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish but is rated insignificant. Projected levels of removals are small and not expected to have a population-level impact. The combined effects of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.

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

- **Reasonably Foreseeable Future External Effects** on the change in biomass are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could result in forage fish mortality. Climate changes and regime shifts have been identified as having potential beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment of some forage species (see Sections 3.5.4 and 3.10). The Alaska subsistence and personal use fisheries have been identified as potential adverse contributors to changes in biomass level of BSAI and GOA forage fish. Subsistence and personal use fisheries concentrate on smelt species, however, it is unlikely that these fisheries would have a population-level effect.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but impacts of the effect are unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the fisheries on the spatial/temporal characteristics of forage fish stocks is unknown.

- **Persistent Past Effects** on the genetic structure of BSAI and GOA forage fish have not been identified. Climate changes and regime shifts may influence reproductive success of BSAI and GOA forage fish. For example, some Osmeridae species have shown a decline in recruitment since the late 1970s, coinciding with an increase in water temperature (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** on reproductive success of forage fish due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has been identified as a potential adverse contribution since acute and/or chronic pollution events could alter genetic structure and/or reproductive success of BSAI and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as potential adverse contributors to the genetic structure and reproductive success of BSAI and GOA forage species. As stated above, these fisheries target smelt species; however, it is unlikely that removals in these fisheries would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect could result from changes to spatial/temporal characteristics of forage fish; however, this effect is unknown. Information on spatial/temporal characteristics of the BSAI and GOA forage fish stocks is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** on changes to prey availability of the BSAI and GOA forage fish stock exists and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** of climate changes and regime shifts on the BSAI and GOA forage fish stock are potentially beneficial or adverse. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment in some species. Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could reduce prey availability or prey quality, thus jeopardizing the stocks' ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potentially adverse contributors in prey availability of BSAI and GOA forage fish. However, the catch/bycatch of these species is expected to be minimal and is unlikely to have a population-level impact.

- **Cumulative Effects**. Although a cumulative effect on prey availability for forage species could exist, potential population-level impacts are not known. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for BSAI and GOA forage fish include climate changes and regime shifts. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment for some forage fish species (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** of climate change and regime shifts on the BSAI and GOA forage fish stocks are potentially beneficial or adverse. Marine pollution may be a potentially adverse contributor since acute and/or chronic pollution events could result in habitat degradation in spawning or rearing success. Alaska subsistence and personal use fisheries are identified as potentially adverse contributors to forage fish habitat suitability (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is possible for BSAI and GOA forage fish habitat suitability; however, potential population-level impacts are unknown. Information on forage fish habitat and possible fishing effects on these habitats is largely unknown at this time.

See Tables 4.5-44 and 4.5-45 for a summary of the cumulative effects on BSAI and GOA forage fish, respectively.

4.9.5 Non-Specified Species Preferred Alternative Analysis

Grenadier have been chosen to illustrate potential effects to non-specified species because they are currently the major catch in this FMP category. Non-specified species is a huge and diverse category encompassing every species not listed in the current FMP as a target, prohibited, forage, or other species. Considering a single species group from this category, such as grenadier, cannot possibly represent the diverse effects to all species in the category. However, because information is lacking for nearly all non-specified species, and due to the small or unknown amounts of bycatch (due to a lack of reporting requirements in this category), only potential effects to grenadier are discussed.

Formal stock assessments are not conducted for grenadier. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to the lack of information needed to establish the baseline condition . Changes in bycatch of grenadier were predicted based on modeled changes in target species catches and population trajectories (sablefish target fisheries account for the highest grenadier bycatch). While changes in bycatch mortality relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes actually impact grenadier populations, or whether these impacts might be adverse, beneficial, or insignificant.

Direct/Indirect Effects PA.1 and PA.2 – Grenadier

Direct and indirect effects for grenadier include mortality, changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking.

Under PA.1, catch of grenadier in both the BSAI and GOA is predicted to remain within or above the currently observed range. In both areas, grenadier catch is predicted to increase initially and then decrease; however, catch rates still remain higher than those currently observed. The significance of these changes to grenadier and other species populations within the non-specified species group cannot be determined, and potential population-level impacts cannot be characterized.

Under PA.2, catch of grenadier in both the BSAI and GOA is predicted to decrease relative to the currently observed catch. In the BSAI, grenadier catch is predicted to decrease by one-half of currently observed levels. In the GOA, catch is predicted to decrease from an estimated 11,000 mt to approximately 8,000 mt per year. The decreased catch of grenadier is due primarily to bycatch reduction incentives included in rationalization programs under PA.2. As stated above, the significance of these changes to grenadier and other species populations within the non-specified species category cannot be determined.

As proposed under PA.2, development of TAC-setting criteria, allowing for a non-specified species to become a managed category, may result in improved management of individual species within the non-specified species group, and minimize potential population-level impacts resulting from bycatch mortality. In addition, improved observer coverage and species identification for non-target species, as proposed in PA.2, may provide reliable bycatch data further supporting the need for more comprehensive management of particular species within the non-specified group.

Cumulative Effects Analysis PA.1 and PA.2 – Grenadier

A summary of the cumulative effects analysis associated with PA.1 and PA.2 are shown in Table 4.9-2. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effects of PA.1 and PA.2 on mortality of grenadier in the BSAI and GOA is unknown. The current baseline condition is unknown and catch information is lacking for all members of the non-specified species category since species identification does not occur in the fisheries.

- **Persistent Past Effects**. No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier, and all other species included in the non-specified species category in the BSAI and GOA, could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA, and federal fishery-caused mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fisheries continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate changes and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects**. For grenadier and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadier, and other species within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for PA.1 and PA.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier, and presumably all other species within the non-specified species complex, are unknown under PA.1 and PA.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** The current reproductive status of grenadier is unknown. It is possible that grenadier, and all other species included in the non-specified species category, in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fisheries continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate changes and regime shifts could have impacts to the reproductive success of grenadier (and other non-specified species) depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadier and all other members of the non-specified species category, will respond to climatic fluctuations.

- **Cumulative Effects**. For grenadier, and all other species within the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadier and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for PA.1 and PA.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effect of the Alternative.** The potential effects of changes in genetic structure of grenadier and other species within the non-specified species complex in the BSAI and GOA are unknown under PA.1 and PA.2. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects**. The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier, and all other species included in the non-specified species category, in the BSAI and GOA, could be disproportionately exploited; however, however, stock status remains unknown. This possible overexploitation could have impacted the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fisheries continue to take grenadier (and other non-specified species) as bycatch. However, their potential impacts to genetic structure of the specific species populations within this complex are unknown. Long-term climate changes and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects**. For grenadier, and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for PA.1 and PA.2.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadier is unknown under PA.1 and PA.2. The current baseline condition is unknown for all members of the non- specified complex, and species-specific catch information is lacking since species identification does not occur in the fisheries. Formal stock assessments are not conducted and grenadier biomass estimates in the BSAI and GOA, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier, and all other species included in the non-specified species category, in the BSAI and GOA, could be disproportionately exploited; however, however, stock status remains unknown. The current non-management of grenadier could mask declines in individual grenadier species and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fisheries continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to the specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate changes and regime shifts could have impacts on the biomass of grenadier and all other members of the non-specified species group depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects**. For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadier and all other species in the non-specified species group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for PA.1 and PA.2.

4.9.6 Habitat Preferred Alternative Analysis

Direct/Indirect Effects PA.1 – Habitat

Example PA.1 illustrates a management approach that accelerates precautionary management measures by increasing constraints where necessary, formalizing precautionary practices in the FMPs, and initiating scientific review of existing practices as a necessary precursor to the decision of how best to incorporate adequate precaution. Three components of the bookend are specific to habitat:

- Developing an MPA process.
- Identifying and designating EFH and HAPC pursuant to MSA rules.
- Maintaining current closed/restricted areas.

The first two components are discussed qualitatively in Appendix F-3 and summarized below. The analysis of direct and indirect effects on habitat of maintaining the current closure areas follows.

Developing an MPA Process

Specific to developing an MPA process as required by Executive Order (EO) 13158, PA.1 incorporates an initiative to develop and adopt definitions of MPAs, marine reserves, marine fishery reserves, and protected marine habitats (see Section 1.0 of Appendix F-3). PA.1 seeks to develop an MPA efficacy methodology including program goals, objectives, and criteria for establishing MPAs. Appendix F-3 discusses specific actions to achieve the objectives for MPA establishment that have been recommended by ADF&G. Section 5.1 of Appendix F-3 suggests a three-phase method for the MPA designation process that could be used under this framework. The methodology employs and expands upon EFH/HAPC considerations, the ADF&G (2002b) recommendations, and suggestions provided by the NRC (2001). As discussed in the appendix, the public, recognized ecological and socioeconomic experts (organized into teams or forums), and interested federal and state agency representatives all have the opportunity to provide input into each step of the MPA candidate selection, designation, and management process.

Identify and Designate EFH and HAPC

As described in Section 1.1 of Appendix F-3, EFH definitions for all managed species are currently being reviewed by the NPFMC and NOAA Fisheries through its EFH amendment process. A decision on the Alaska EFH definitions will be made by August 2005. The Assistant Administrator of NOAA Fisheries determined that the agency would prepare new regional EISs to include all FMPs covered by the EAs. The proposed action to be addressed in the EFH EIS is the development of the mandatory EFH provisions of all five FMPs of the NPFMC; the BSAI groundfish FMP, GOA groundfish FMP, BSAI king and Tanner crab FMP, scallop fishery off Alaska FMP, and the FMP for the salmon fisheries in the EEZ off the coast of Alaska. At present NOAA Fisheries and the NPFMC are identifying feasible alternatives for analysis in the EIS for NPFMC's eventual selection of a preferred alternative. The Alaska Groundfish Programmatic SEIS is not intended to replace or supercede the EFH EIS, but will provide overarching policy guidance for EFH and will set the stage for future FMP actions.

According to the Final Rule implementing the EFH provisions of the MSA (50 CFR Part 600), to identify EFH basic information is needed to understand the usage of various habitats by each managed species. Pertinent information includes the geographic range and habitat requirements by life stage, the distribution and characteristics of those habitats, and current and historic stock size as it affects occurrence in available habitats. Temporal and spatial distribution of each life history stage is necessary to understand each species' relationship to, or dependence on, its various habitats. Data summarizing all environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species should be provided.

The NPFMC (1999) identified EFH information levels for groundfish, crab, scallops, and salmon in the Alaska regions. Level 2 data is available for some adult life history stages of groundfish, crabs, and shellfish. Level 2 data is available for some stocks of red and blue king crab, and Tanner and snow crab stocks in some regions, at the egg, larval, late juvenile, and adult stages. The remainder of the data for all other crab stocks is either at Level 1 or unknown. Level 1 data is available for the eggs, larvae, early juvenile, and late juvenile stages of pollock, and for the late juvenile stages of most other groundfish species. Even minimal (Level 1) data are not available for forage fish at all life stages, so distribution and habitat use are considered to be unknown. Salmon EFH data are highly variable and cross Levels 1 through 4 depending on species, stock, and life stage. The majority of the data available for adults in the freshwater stage ranges from Levels 1 to 3. The information levels for all EFH are continually being refined and updated and will be presented in the EIS currently being developed for EFH.

Maintaining Current Closed and Restricted Areas

There are no additional bottom trawl closures relative to the baseline, and there will be decreases in fishing effort. Figure 4.2-8 (bookend first appears in a previous section) illustrates the PA.1 suite of year-round closures in the BSAI and GOA management areas. Since the closure areas remain the same as in FMP 1, FMP 2.2, and FMP 3.1, impacts to habitat under PA.1 should be similar to those described previously for these FMPs. A summary of direct and indirect impacts of PA.1 is provided in Table 4.9-3.

As shown on Table 4.9-3, direct and indirect effects of the FMP on habitat are discussed for changes to living habitat through direct mortality of benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to their habitat type differences, the BSAI and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

The habitat impacts model predicts the following effects for PA.1 on biostructure relative to the baseline:

- **Bering Sea.** There is no predictable difference from the baseline where mean impacts are low when averaged over entire fishable EEZ. As with the baseline, impacts to biostructure ranged from 1.8 to 9.3 percent of the fishable EEZ and from 8.2 to 41.9 percent of the fished area (see Table 4.1-26). Based on these results, we conclude that there would be an insignificant change to mortality and damage to living habitat as a result of PA.1 as compared to the baseline. However, the baseline condition is considered to be already adversely impacted. Thus, the rating is based on the insignificant change between PA.1 projections and the comparative baseline.

- **Aleutian Islands.** There is no predictable difference from baseline (Table 4.1-26). Therefore, we rate the change resulting from PA.1 on the baseline as insignificant. However, the prevalence of long-lived species of coral in the bycatch is a particular concern in the Aleutian Islands under PA.1. With a recovery rate for red tree coral possibly as low as $\rho = 0.005$ (200 years) and sensitivity $q_h = .27$, the habitat impact model indicates that fishing intensity as low as $f = 0.10$ (total area swept once every ten years) results in an equilibrium level reduction of 85 percent relative to the unfished level. About 9 percent of the area is estimated to be fished at $f = 0.10$ or greater. This amounts to 3,590 square miles of area. Thus, continued bycatch and damage to living habitat at PA.1 bycatch levels may have adverse consequences on habitat quality, and PA.1 would not change this risk.

- **GOA.** There is no predictable difference from baseline where estimates of equilibrium impact on biostructure averaged over entire fishable EEZ range from 0.9 to 6.9 percent of the fishable area and 3.8 percent to 29.0 percent of the fished areas (see Table 4.1-26). Only 2 percent of the fishable EEZ is impacted to a level potentially below 32 percent of unfished levels, but amounts to about 2,418 square miles of habitat in scattered concentrations. Therefore, for PA.1, we rate this change to mortality and damage to living habitat as insignificant. However, the baseline condition is considered to be already adversely impacted.

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

- **Bering Sea.** Identical to the baseline and FMP 1, PA.1 closures in the Bering Sea are mostly concentrated on sand substrate (Table 4.5-47). Only 27 percent of the geographical- habitat zones have greater than or equal to 20 percent of their area closed to bottom trawling. Figure 4.1-10 shows that the amount of large contiguous areas of high fishing intensity—that is, areas that are swept at least once each year with bottom trawls—exceeds 8,000 square miles (Table 4.1-26). Table 4.5-49 shows that of the Bering Sea fishable area, 19.3 percent is closed to bottom trawling under FMP 1 and is identical to PA.1. However, very little geographic diversity of fishing impacts occurs within the closed habitats, and nearly all of the closures are not year-round. Figure 4.5-4 shows areas closed to trawling only at various times of the year under FMP 1 and PA.1, while Figure 4.5-5 depicts just those areas closed to fixed gear only.

Application of the habitat impacts model indicated that, depending on the sensitivity and recovery parameters thought plausible, fishing of this intensity could reduce the amount of biostructure in the area by 13 to 75 percent of its unfished level equilibrium level (Table 4.1-26). Such biostructure includes sponges, soft corals, tunicates, and anemones (Heifetz 2002, Malecha *et al.* 2003). In these habitat areas, no existing closure areas abut these intensely fished areas to provide a diverse level of impact. While existing closures tend to be large and cover all of the particular habitat, they provide little diversity in fishing impacts. The primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear, and they do not necessarily cross a wide range of habitat types. Some of the trawl closures are in effect year-round while others are seasonal (see Section 3.6). However, compared to the existing baseline the predicted effects of PA.1 on benthic community diversity are insignificant. Similarly, the predicted effects of PA.1 on geographic diversity of impacts are predicted to be insignificant. However, as described above for direct mortality, the baseline condition is considered to be already adversely impacted.

- **Aleutian Islands.** Identical to the baseline and FMP 1, PA.1 closures in the Aleutian Islands are concentrated in shallow water where only 4 percent of the area is closed to bottom trawling year-round for all species. However, as shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutian Islands is closed to bottom trawling at one time or another during the year under FMP 1, and similarly under PA.1. These closures are associated with sea lion rookeries. As in the baseline, there is very little diversity in protection. Less than one percent of the deep area is closed to bottom trawling. Figure 4.1-10 shows that none of the closure areas extends over any blocks of significant fishing effort. Figures 4.5-4 and 4.5-5 show the closure areas under PA.1 broken down by gear type for bottom trawl and fixed gear, respectively. The Aleutian Islands bathymetry and habitat are distributed on a very fine scale, with fishing effort that is very patchy and in very small clusters. Based on comparison of these observations to the baseline, the predicted effects of PA.1 on benthic community diversity and geographic diversity of impacts are insignificant, but the baseline condition is considered to have already experienced adverse impacts.

- **GOA.** Figure 4.5-6 shows that, as in the baseline, minimal geographic diversity of impact or protection results from the current suite of closed areas. Except for the southeast trawl closure which covers several entire habitats, all other closures are inshore, and none exists on the outer shelf or slope (see Figure 4.5-6). As shown on Table 4.5-49 and Figures 4.5-4 and 4.5-5, PA.1 closes nearly 46 percent of the fishable area in the GOA to trawling at one time or another during the year. The inshore closure areas tend to be large relative to the size of bathymetric and habitat resolution scale and thus tend to encompass much of a bathymetric feature. Based on these results, the predicted effects of PA.1 on benthic community diversity and geographic diversity of impacts are insignificant, but the baseline condition is considered to be in an adversely impacted state.

Cumulative Effects PA.1 – Habitat

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

Bering Sea

Changes to Living Habitat – Direct Mortality of Benthic Organisms

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

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use is possible at several locations in the Bering Sea area including Port Moller, Port Heiden, Dillingham, St. Paul and St. George. Again the impacts include mortality due to smothering and/or burying and would affect only nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Again, areas more likely to be impacted would be located nearer to shore. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Bering Sea benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue and add to the adverse consequences on benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the community structure is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, all have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind induced waves and surges could cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific. These changes could have either beneficial or adverse effects on the benthic community (see Sections 3.6 and 3.10).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Bering Sea. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue and add to the adverse consequences to benthic living habitat.

Geographic Diversity of Impacts and Protection

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

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 illustrate the spatial measures that were in effect before 1980 or were later established by regulations following the publication of the Final Groundfish SEIS in November of 1980. As discussed in Section 3.6, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to spatially and temporally restrict the foreign fishery to prevent conflicts with domestic fisheries through bycatch of species important to U.S. fishermen, or grounds preemption and gear conflicts. Most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that back in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This again was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time.

- **Reasonably Foreseeable Future External Effects.** These include port expansion and the potential resultant changes to offal discharge and marine pollution events. As ports in the Bering Sea are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, the opening of new ports may allow vessels of all sizes to access new or relatively unfished areas. On the other hand, depending on distribution, fishing pressure in heavily fished areas may be eased as access to other areas becomes available. Of course, closed areas proposed to continue under PA.1 would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.1 would protect more benthic habitat from trawl gear in the future (19 percent) than was protected in 1980 (8.6 percent). However, the spatial distribution of the closed areas under PA.1 will not protect the full range of habitat types or provide for a diversity of impacts within fished areas. Existing closures tend to be large and cover all of particular habitat. They provide little diversity in fishing impacts since the primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear. (See direct/indirect effects discussion and baseline description in Section 3.6). The additional external impacts do not provide any protection and could add to the lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 1 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished and impacts would occur in areas not previously impacted.

Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the baseline is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutian Islands. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Dredging due to scallop fisheries and/or navigation can occur in localized areas, often in conjunction with port development and can cause burial or smothering of benthic fauna. Damage to living substrates by longline and pot fisheries (see Section 3.6) has been documented and is expected to continue in those heavily fished areas. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent at inshore closed bay locations. However, improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use is possible at several locations in the Aleutian Islands including Atkutan, Adak, Unalaska, Cold Bay, Dutch Harbor, and King Cove. Again the impacts include mortality due to smothering, and/or burying and would affect only nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Aleutian Islands benthic organisms. Long-lived species such as tree coral are more prevalent in the Aleutian Islands. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, bycatch and damage to living habitat in the Aleutians will continue and will add to the adverse consequences to benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the community structure is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 3.6). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline and pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind induced waves and surges could cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above for mortality, all of these impacts are more likely to be observed in nearshore areas. Regime shifts and large-scale environmental fluctuations associated with ENSO and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Aleutian Islands. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, continued bycatch and damage to living habitat will add to the adverse consequences on the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the baseline is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed above for the Bering Sea, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. They gave priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 about 31 percent of the fishable area in the Aleutian Islands was closed to trawling with about 6 percent closed to all fishing. There were no longline only closures in the Aleutian Islands at that time.

- **Reasonably Foreseeable Future External Effects.** These include other fisheries, port expansion, and the potential resultant changes to offal discharge and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As with the Bering Sea, ports in the Aleutian Islands will be expanded and new ports created, and additional dock space for harboring the fishing fleet will be made available. While the fleet might not necessarily expand, the distribution of fishing effort is likely to change and previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.1 would protect more benthic habitat from trawl gear in the future (43 percent) than was protected in 1980 (31 percent). However, the spatial distribution of the closed areas under the current FMPs may not protect the full range of habitat types.

GOA

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

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the benthic community is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As described for the BSAI, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Port expansion and increased use is possible at several locations in the GOA including Kodiak, Sand Point, Chignik, Port Lions, Ouzinkie, Valdez, and Seward. The impacts include mortality due to smothering and/or burying and would likely affect only nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organism.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of GOA benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, continued bycatch and damage to living habitat in the GOA will add to the adverse consequences of fishing on the mortality of benthic organisms.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the community structure is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 3.6). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As with the other regions, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to GOA benthic communities. As discussed above, these changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the GOA. The additional external impacts described above will add to the lingering past impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, bycatch and damage to living habitat will continue in the GOA and will add to the adverse consequences of fishing.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.9.6, this effect is judged to be insignificant; however, the baseline is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed for the other groups, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring, and there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, and about 7 percent was closed to all fishing. The largest closures in the GOA concerned longline fishing where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980 about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at one time throughout the year.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion, and the potential resultant changes to offal discharge and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As ports in the GOA are expanded and new ports are created, additional dock space for harboring the fishing fleet is made available, and changes in the distribution of fishing effort would result. Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.1 would protect much more benthic habitat from trawl gear in the future (46 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under the PA.1 may not protect the full range of habitat types. Also, in 1980 more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under PA.1 (less than one percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. The additional external impacts described above will add to the lingering impacts and contribute to impacts that are already evident.

Direct/Indirect Effects PA.2 – Habitat

This FMP contains a composite of several different concepts for habitat protection and mitigation. Figure 4.2-9 illustrates the suite of year-round closures in the BSAI and GOA management areas. These areas are essentially the same as those proposed for and analyzed under FMP 3.2 and can be considered a proxy for what might actually be implemented by NPFMC under this PA. The conceptual strategies for the proxy include:

- Review all existing closures to see if the areas qualify for MPAs. An MPA could include no-take marine reserves, establishing specific gear restrictions, or restrictions on specific fisheries. An example under PA.2 would be bottom trawl closures located in specific areas on the GOA upper slope that possess sensitive hard bottom habitats impacted by the rockfish fishery.

- Consider adopting 0 to 20 percent of the BSAI and GOA as MPAs and no-take marine reserves (e.g., 5 percent no take and 15 percent MPA across a range of habitat types). A proxy for this strategy would be to incorporate a band-approach where closures would be oriented perpendicular to depth contours from nearshore to deep water assuring protection of a diversity of habitat types across a range geographic areas.

- Develop a special conservation area in the Aleutian Islands to protect sensitive cold water coral communities.

- Implement rotational closures in the Bering Sea to mitigate for impacts.

In the following analysis, we examine qualitatively the relative merits of these conceptual approaches.

- **Slope Rockfish Closures.** The basis for these conceptual closures is to illustrate how the effects of fishing on EFH can be mitigated by reducing the impacts caused by a particular fishery. This concept is currently being developed for the GOA slope rockfish fishery by the NPFMC EFH committee. The GOA closure scheme selected by the EFH committee was based on a very preliminary run of the habitat impacts model. Further research may identify other fisheries and areas that would be better candidates for habitat mitigation. Note that the exact location used in the analysis presented here does not correspond to those areas being studied by the NPFMC and NOAA Fisheries in the EFH SEIS. They only serve to illustrate the concept. Independent of the habitat impacts model, it is worth noting that GOA rockfish fisheries are responsible for a considerable portion of the bycatch of living substrates, especially coral and sponges.

It must be emphasized that the NPFMC and NOAA Fisheries need to carefully consider the location of closures so that unintended consequences do not occur. Displacement of effort to new areas with more sensitive habitat may be an unintended consequence. If closures are placed primarily in areas with high fish densities and displacement of effort occurs in areas of low densities, then increased effort and potentially more habitat impacts may occur overall. For this ,reason the NRC (2002) suggests that for closures to be most effective they should be combined with some effort controls. The example PA.2 does illustrate a scenario of reduced TACs, and the use of fishery cooperatives combined with no-take reserves and MPAs. However, it is important to point out that closures alone, if they are strategically placed within historically fished areas, can provide benefits to habitat overall without necessarily requiring a reduction in TACs. The benefits to habitat can be enhanced by having areas selected for closure to be located within historically fished areas. This patchiness promotes habitat diversity (Duplisea *et al.* 2002).

- **Rotational Closures.** These closures have been suggested as a concept of protecting seafloor habitat while not permanently closing an area to fishing and illustrate how the year-round closures shown in Figure 4.2-9 could be managed. Conceptually, rotational closures are not that much different from the concept of rotating crops. The theory is that by allowing some areas (fields) to go to seed and recover to a more natural state, benefits accrue to both habitat and food production objectives. However, rotational closures are not appropriate for highly structured seafloor habitats with long-lived species. Rotational closures need to be tied to recovery times of living habitats and may only be a viable alternative in sandy energetic habitats inhabited by short-lived animals. Specific knowledge of recovery times is required because if the rotation schedule is less than the recovery time then all areas may be maintained in a disturbed state with little benefits to habitat or yield. For example, during a temporary trawl closure in the North Sea, fishing effort was displaced outside the closed area and then returned when the area was re-opened several years later (Rijnsdorp *et al.* 2001). The net result was a more homogeneous distribution of fishing effort and habitat disturbance than in years prior to the closure. From a habitat perspective it is preferable to keep fishing effort patchy (Duplisea *et al.* 2002) because repeated tows of the same area cause a diminishing mortality of benthic species and some areas remain unfished. Thus, permanently closed areas are preferred over temporary or rotating closures (Collie *et al.* in review).

- **Aleutian Island Special Management Area.** The Aleutian Islands most likely harbor the highest diversity and abundance of cold water corals and sponges in the world (Heifetz 2002). A recent expedition to the Aleutian Islands used the manned submersible DSV Delta and scuba to explore coral and sponge habitat in the Aleutian Islands near the Andreanof Islands and on Petrel Bank (NPFMC 2002b). Dive observations confirmed that coral and sponges are widely distributed in that region; corals and sponges were found at 30 of 31 submersible dive sites. Disturbance to epifauna, likely anthropogenically induced, was observed at most dive sites and may have been more evident in heavily fished areas. Percent coverage of corals ranged from approximately 5 percent on low-relief pebble substrate to 100 percent coverage on high-relief bedrock outcrops. Unique coral habitat consisting of high density gardens of corals, sponges, and other sessile invertebrates was found at five sites between 150 and 350 m deep. These gardens were similar in structural complexity to tropical coral reefs and shared several important characteristics with tropical reefs including complex vertical relief and high taxonomic diversity. The uniqueness and fragility of this habitat points to the need for the design of special management regime that protects this habitat yet allows fishing. Strategically placed closures in areas of sensitive habitat would protect such habitat as long as the displaced fishing effort does not occur to new areas with equally or more sensitive habitat. Unfortunately, there exists little information on the locations of these fragile habitats throughout the Aleutian Islands. Locating and mapping these areas is a priority for research. In the interim, one precautionary measure would be to restrict fishing to those areas that are known to have little or no sensitive habitat.

- **Band Approach.** Incorporation of a band-approach where closures are oriented perpendicular to depth contours from nearshore to deep water would assure protection of diversity of habitat types across a range of geographic areas. This concept has appeal in situations where little is known about benthic habitat types and location. Ideally these closures would be placed to ensure a diversity of habitat types are protected. However, lacking good scientific information on distribution of habitat types, alternatives would randomly or systematically place the closures equidistant apart. In theory, this strategy should promote habitat diversity and protect a wide range habitat types from the effects of fishing. Mitigation and diversity of impacts can occur if closures incorporate fished and unfished areas. One adverse aspect of such random placement is that such closures could have serious social and economic consequences. Determining where to apply this broad approach, should include consultation with the fishing industry and nearby communities.

As shown on Table 4.9-3, direct and indirect effects of the FMP on habitat are discussed for changes to living habitat through direct mortality of benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to their habitat type differences the BSAI and GOA are rated and discussed separately.

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

In the GOA, the multi-species model results indicate that the bycatch of coral is projected to decline under PA.2. This is realistic because PA.2 has reduced TAC levels for some target species, especially rockfish. These reduced TACs should result in less fishing effort.

If the magnitude of such declines are actually realized, then this could have beneficial impacts on living substrates possibly resulting in increased abundance of some species of living substrates over baseline levels. Such abundance increases for short-lived biota with fast recovery rates may occur relatively quickly. For other species of living substrates such as long-lived corals and perhaps some sponges that have been permanently eradicated from some areas, increases over baseline levels may not occur or occur very slowly. Conceptual deductions from the habitat impacts model yield the following inferences:

- **Bering Sea.** Based on the location of the PA.2 closures relative to the distribution of fishing intensity shown in Figure 4.7-1, the change relative to the baseline in total impact to biostructure would likely be slight and insignificant. The baseline condition is considered to already be adversely impacted. However, there are some reductions in TAC which may result in some reduction in impacts. Most of the closure areas are located in sand habitat with moderate amounts of closure in sand/mud habitat and almost no closures in mud habitat. The closed areas are located in areas that have been lightly fished compared to large areas of heavy fishing that are left open. Whether mean impact increases or decreases depends on relative density of target species and habitat in the open and closed areas, and the respective impact/recovery parameters (q, q_h, and ρ) in the open and closed areas. There is little information to indicate that habitat density and the parameters would differ between the open and closed areas. One would expect target species density to be lower in areas of low fishing intensity and higher in the areas of high fishing intensity. If closed areas are of lower historical fishing density, benefits to habitat are likely minimal. If target species density is higher in the closed areas, benefits to habitat from the closure would increase.

- **Aleutian Islands.** A decrease in mean equilibrium impact would probably occur in the Aleutian Islands due to the specific closures depicted by the PA.2 bookend. Closures where fishing occurs seem to bisect the cluster of historical fishing patterns leaving the adjacent area open (Figure 4.7-1). Some reductions in TAC may result in less habitat impacts. Based on these results, we conclude that there would be a significantly beneficial change to mortality and damage to living habitat as a result of PA.2. However, as described above, the baseline condition is considered to already be adversely impacted.

- **GOA.** The mean impact will increase in the GOA, as many of the closed areas are centered on high effort areas which would be expected to have higher target fishery species densities (Figure 4.7-2). This results in a much higher effort to catch fish in lower density open areas. This much higher effort will result in enough of an increase in habitat impacts to negate impact reduction in the closed areas. It is not clear whether decreased TACs for some species will offset this increase in habitat impacts. Based on these results, we conclude that, under certain conditions, there could be significantly adverse changes to mortality and damage to living habitat as a result of PA.2. Therefore, the internal effect is rated as conditionally significant adverse, and the baseline condition is considered to already be adversely impacted.

<u>Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection</u>

- **Bering Sea.** Closures are fairly well distributed among geographical-habitat types. Some improvement in geographic diversity would be achieved. While large expanses of high fishing intensity still remain open in this FMP, there is at least one closure area that covers a portion of high fishing intensity as shown in Figure 4.7-1. This provides some improvement in the geographic diversity of impacts. An overall improvement to geographic diversity of impacts could be realized with smaller closure areas, some of which covering a small fraction of the heavily fished areas. Some of the closures for this FMP are located where light levels of fishing occur and may provide some low-level of contrast and diversity. Table 4.5-49 shows that of the Bering Sea fishable area, nearly 33 percent is closed to bottom contact at one time or another during the year under PA.2. Figure 4.7-3 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.7-4 depicts those areas closed to fixed gear only. Based on these results, the predicted effects of PA.2 on benthic community diversity are conditionally significant beneficial. The predicted effects of PA.2 bookend on geographic diversity of impacts are significantly beneficial. However, the baseline is considered to already be adversely impacted.

- **Aleutian Islands.** Closures illustrated in PA.2 bookend are well distributed among geographical-habitat types. Improvement in geographic diversity of impacts would occur under this FMP scenario. As shown on Table 4.5-49, about 80 percent of the fishable area in the Aleutian

Islands is closed to bottom contact at one time or another during the year under this FMP, and these closures are well distributed over a range of geographical-habitat zones. Figures 4.7-3 and 4.7-4 show the closure areas under PA.2 broken down by gear type; bottom trawl and fixed gear, respectively. While the closure areas are especially large compared to the resolution of the bathymetry and fishing distribution and encompass different habitat types at a time, it may well be that a similar mix of habitat types occur adjacent to the closure areas. Also, Figure 4.7-1 shows that some closure areas happen to bisect apparent historic clusters of fishing patterns, thus providing a contrast in impact for the habitat being fished. Based on these results, the effects of PA.2 on benthic community diversity are significantly beneficial. The predicted effects of PA.2 bookends on the geographic diversity of impacts are significantly beneficial. However, the baseline is considered to already be adversely impacted.

- **GOA.** Closures illustrated by the PA.2 bookend are well distributed among geographical-habitat types. However, slight, if any, improvement in geographic diversity of impact would result. As shown on Table 4.5-49 and Figures 4.7-3 and 4.7-4, PA.2 closes over 72 percent of the fishable area in the GOA to bottom contact at one time or another during the year. The closure areas are large in relation to the GOA spatial habitat or bathymetric resolution, and thus tend to encompass much of a bathymetric feature. Figure 4.7-2 shows that closures often encompass clusters of historically high fishing intensity, leaving little diversity or contrast of fishing intensity within a bathymetric feature or habitat type. An overall improvement to geographic diversity of impacts could have been realized with smaller closure areas strategically placed to not encompass entire habitat types or clusters of fishing intensity. For example, the closure areas on the upper slope should include some portion of areas where high fishing intensity has occurred, but need not be as large in size as illustrated in this PA.2 scenario. Based on these results, the predicted effects of PA.2 bookend on benthic community diversity and geographic diversity of impacts are found to be insignificant relative to the baseline. However, the baseline is considered to already be adversely impacted.

Cumulative Effects PA.2 – Habitat

Cumulative effects of habitat for PA.2 are summarized on Table 4.9-3.

The following discussion of the results presented on the table is broken down by geographic area.

Bering Sea

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

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

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. These effects include persistent mortality of long-lived species such as tree corals and other sessile epifauna (see the cumulative effects discussion for PA.1 in this section).

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat (see the Bering Sea PA.1 cumulative effects discussion in this section).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Bering Sea benthic organisms. There is little information to indicate that habitat density and the parameters would differ between the open and closed areas. The baseline condition is considered to be adversely impacted. Although some benefits accrue within the proposed MPAs, impacts from fishing are not totally eliminated, and TAC effort is likely to remain high. While there is an incremental expansion of no-take MPAs, the closures analyzed under this FMP are not refined and may not be effective. We do not know for certain where future closures may be, or whether they would be no-take reserves or a form of gear-specific/species-specific MPA. Due to this uncertainty, along with the already impacted baseline, and with the addition of the external impacts on mortality described above, the cumulative effect of the FMP on mortality could be conditionally significant adverse.

  However, if the closures proposed under PA.2 were to be further defined based on additional information regarding important habitats in need of protection, and were properly designed and located to protect the sensitive habitats, future closures could provide successful mitigation of the effects of fishing. Overtime, valued habitat that has been adversely affected by fishing could recover. Therefore, under that condition, cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be conditionally significant beneficial, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea (see the Bering Sea PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities as described for PA.1. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Bering Sea. This FMP provides some improvement in the geographic diversity of impacts. However, some of the closures for this FMP are located where light levels of fishing occur and may provide some low level of contrast and diversity. As described above for mortality, while benefits accrue due to the MPAs, the closure areas are not refined and may not be effective in protecting benthic community structure (see the discussion provided above for mortality). For these reasons, along with the already impacted state of the communities and the external adverse impacts, the FMP is rated as conditionally significant adverse in the cumulative case.

  However, as described above for mortality, if the closures proposed under PA.2 were to be further defined and designed to protect important habitats, mitigation of fishing-related impacts could occur. Cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

Geographic Diversity of Impacts and Protection

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

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time. The cumulative effects section for PA.1 provides additional discussion regarding these past effects.

- **Reasonably Foreseeable Future External Effects.** These include port expansion and the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes (see the discussion for PA.1 in this section). Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.2 would protect more benthic habitat from trawl gear in the future (33 percent) than was protected in 1980 (8.6 percent). Closure areas under this scenario cover a portion of high fishing intensity, thereby providing improvement in the geographic diversity of impacts. However, since TAC is likely to remain high and the locations of the proposed MPAs are not refined, the benefits provided by the closed areas are uncertain. Previously unfished areas would likely be fished and impacts would occur in areas not previously impacted. The additional external effects in combination with the past and predicted internal effects are judged to be conditionally significant adverse. However, as described above for mortality and community diversity, better definition and focus of the closures could lead to a conditionally significant beneficial rating.

Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

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

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutian Islands. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** As described for PA.1 cumulative effects in the Aleutian Islands, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Aleutian Islands benthic organisms. As described above for the Bering Sea, the baseline condition is considered to be already adversely effected. The proposed no-take MPAs will allow some benefits to accrue, but impacts will still occur, especially since TAC remains high. Therefore, the overall effect would be significantly adverse under certain conditions. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be significantly beneficial; however the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see the Aleutian Islands PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** As described for PA.1, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Aleutian Islands. As described above for mortality of benthic organisms, the existing impacted baseline, combined with the uncertain benefits of the proposed MPAs, leads to a conclusion of significantly adverse under certain conditions in the cumulative case. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

<u>Geographic Diversity of Impacts and Protection</u>

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

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 31 percent of the fishable area in the Aleutian Islands was closed to trawling with about 6 percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time (see the PA.1 Aleutian Islands cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** These include other fisheries, port expansion, the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case (see the Aleutian Islands PA.1 cumulative effects discussion in this section).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.2 would protect more benthic habitat from trawl gear in the future (80 percent) than was protected in 1980 (31 percent). Closures illustrated in PA.2 bookend are well distributed among geographical-habitat types; thus, improvement in geographic diversity of impacts would occur under this FMP scenario. However, since TAC is likely to remain high, and the locations of the proposed MPAs are not refined, the benefits provided by the closed areas are uncertain. Previously unfished areas would likely be fished and impacts would occur in areas not previously impacted. The additional external effects in combination with the past and predicted internal effects are judged to be conditionally significant adverse. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, this effect is judged to be conditionally significant adverse, since there would be much higher effort to catch fish in lower density open areas. It is not clear whether decreased TACs for some species will offset an increase in habitat impacts. Under certain conditions, there could be significantly adverse impacts on mortality of benthic organisms.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the GOA PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** As described for PA.1, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of GOA benthic organisms. The external effects identified above have the potential to provide additional mortality to benthic organisms. Therefore, under certain conditions, the cumulative effects on mortality could be significantly adverse.

Changes to Benthic Community Structure

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

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see the GOA PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** As described for PA.1 in the GOA, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the GOA. As described above for the BSAI, while the FMP provides for additional closure area and no-take MPAs, impacts are not totally eliminated, and the proposed MPAs might not be effective. Therefore, the combination of internal and external impacts on benthic communities is judged to be conditionally significant adverse in the cumulative case. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

Geographic Diversity of Impacts and Protection

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

- **Persistent Past Effects.** Persistent past effects are expected, since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, with about seven percent closed to all fishing. The largest closures in the GOA concerned longline fishing where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980 about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at one time throughout the year (see the GOA PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** These include other fisheries, port expansion, the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution events (see the GOA PA.1 cumulative effects discussion in this section). Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.2 would protect much more benthic habitat from trawl gear in the future (72 percent) than was protected in 1980 (16 percent). Closures illustrated by the PA.2 bookend are well distributed among geographical-habitat types. However, slight, if any, improvement in geographic diversity of impact would result. As described above for the BSAI, the proposed MPAs might not be effective. Further refinement of the proposed MPAs may lead to a conditionally significant beneficial rating.

4.9.7 Seabirds Preferred Alternative Analysis

The seabird-specific policy goal of the Preferred Alternative (PA) is the same as all the other Alternatives, to “Avoid Impacts to Seabirds and Marine Mammals”. The PA contains one policy objective that is specific to protecting seabirds, “Continue to cooperate with USFWS to protect ESA-listed species and, if appropriate and practicable, other seabird species”. The NPFMC could adopt a range of specific management measures in order to implement the policy objectives. The illustrative FMP bookends provide examples of specific management measures the NPFMC would take to implement the Preferred Alternative policy objectives. PA.1 includes the following measures: 1) Take of more than 4 short-tailed albatross within 2 years triggers consultation in groundfish longline fisheries, 2) Maintain current seabird avoidance measures for the longline fleet that were approved at the December 2001 NPFMC meeting, 3) Cooperate with USFWS to develop scientifically-based fishing methods that reduce incidental take of ESA-listed seabird species in the trawl sector. PA.2 retains the first objective for short-tailed albatross take and substitutes the following for the other two objectives: 2) For the longline sector, cooperate with USFWS to develop scientifically-based fishing methods that reduce incidental take for all seabird species, 3) For the trawl sector, cooperate with USFWS to evaluate and implement scientifically-based fishing methods that reduce incidental take of ESA-listed, and if appropriate and practicable, other seabird species. The PA also includes several goals and objectives that would have indirect effects on seabirds, such as the ban on directed forage fish fisheries, modification and potential expansion of the Observer Program based on scientific data needs, the development of ecosystem indicators for use in the TAC-setting process, and the potential establishment of Marine Protected Areas.

Two important agency actions that are pertinent to BSAI/GOA seabirds and the following analysis have occurred since the Draft PSEIS was published in 2003. First, the USFWS issued two Biological Opinions (BiOps) in September 2003 as part of their ESA Section 7 consultations on the federal groundfish fisheries (see NOAA Fisheries website: http://www.fakr.noaa.gov/protectedresources/seabirds.html.). One BiOp takes a programmatic look at the impacts of the BSAI/GOA groundfish FMPs and associated fisheries on the endangered short-tailed albatross and the threatened Steller's eider (USFWS 2003a) while the other BiOp concerns the TAC-setting process for these fisheries (USFWS 2003b). These documents conclude that the fisheries would not likely jeopardize the continued existence or recovery of either the short-tailed albatross or Steller's eider and would not adversely modify Steller's eider critical habitat (no critical habitat has been designated for short-tailed albatross in U.S. waters). The TAC-setting BiOp included updated Incidental Take Statements for these species. For short-tailed albatross, incidental take on longline gear is anticipated to be the same as previous years, with up to 4 birds taken every two years. In addition, for the first time the USFWS included an anticipated take for short-tailed albatross through collisions with trawl gear. Unlike the situation with the longline fleet where there is over ten years of Observer Program data on take of albatross, the USFWS and NOAA Fisheries have only recently begun investigating how frequently albatross may be colliding with trawl gear. Because of this uncertainty, the Incidental Take Statement anticipates up to 2 birds could be taken by the trawl fleet but the time period was left open until the BiOp is superceded by a new one. This open-ended period allows USFWS and NOAA Fisheries to continue gathering data on the potential risk of trawl gear before a new Section 7 consultation is initiated.

The TAC-setting BiOp also included mandatory terms and conditions that NOAA Fisheries must follow in order to be in compliance with the ESA. One is the implementation of seabird deterrent measures for the longline fisheries as proposed by NOAA Fisheries in February 2003 (see below). Other provisions include continued outreach and training of fishing crews as to proper deterrence techniques, continued training of observers in seabird identification, retention of all seabird carcasses until observers can identify and record takes, continued analysis and publication of estimated incidental take in the fisheries, collection of information regarding the efficacy of seabird protection measures, cooperation in reporting sightings of short-tailed albatross, and continued research and reporting on the incidental take of short-tailed albatross in trawl gear.

The second pertinent agency action was the publication of new seabird protection regulations for longline vessels that were based on the joint recommendations of NOAA Fisheries, USFWS, and the Washington Sea Grant Program, approved by the NPFMC in December 2001, proposed by NOAA Fisheries in February 2003 (68 FR 6386), and were enacted in final regulations on January 13, 2004 (69 FR 1930) . These regulations are in effect as of February 2004 and vary by length of vessel, area fished, type of gear, and other factors. They are available at NOAA Fisheries website: http://www.fakr.noaa.gov/protectedresources/seabirds.html.

4.9.7.1 Short-Tailed Albatross

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

Incidental take of the endangered short-tailed albatross in the groundfish fishery is a very rare event, with the last recorded takes occurring in 1998 (see Section 3.7.4 for a history of takes and agency actions taken to protect this species under the ESA). The seabird protection measures that were in effect for the longline fleet prior to the 2004 fishing season had been in place since 1997 and constitute the baseline condition for this analysis. These measures had been strongly influenced by the goal of protecting short-tailed albatross but had not eliminated incidental take, as evidenced by two takes of short-tailed albatross in one month in 1998. A great deal of research and development has been conducted since 1997 to improve the efficacy of seabird protection techniques in the longline fleet. PA.1 would maintain the new seabird protection measures for longline vessels that were enacted in January 2004 (69 FR 1930) . These new regulations are based on the demonstrated effectiveness of using particular deterrent devices to reduce the incidental take of other albatross species (Melvin *et al.* 2001) and are expected to substantially reduce the chances of taking short-tailed albatross on longlines.

Under PA.1, NOAA Fisheries and USFWS would continue current research to develop ways to reduce the risk of short-tailed albatross colliding with trawl gear. Under PA.2, NOAA Fisheries would continue to cooperate with USFWS and other groups to scientifically develop and implement mitigation measures that further reduce the risk of taking short-tailed albatross in both the longline and trawl sectors.

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

Availability of Food

Short-tailed albatross forage over vast areas of ocean on species that are taken in minimal amounts by the groundfish fishery and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under either PA bookend. Both PA.1 and PA.2 are considered to have insignificant effects on short-tailed albatross through availability of food.

Benthic Habitat

Short-tailed albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under either PA bookend. Both PA.1 and PA.2 are considered to have no effects on short-tailed albatross through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on short-tailed albatross are described in Section 3.7.4 (Table 3.7-11) and the predicted direct and indirect effects of the groundfish fishery under the PA.1 and PA.2 are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for this species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.1 (Table 4.5-52) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under both PA.1 and PA.2, new seabird protection measures on the longline fleet (Section 3.7.1) and possibly the trawl fleet should substantially reduce the chances of taking short-tailed albatross incidentally in the groundfish fishery. Incidental take of short-tailed albatross is predicted to be a very rare event in the groundfish fishery and is considered insignificant at the population level.

- **Persistent Past Effects.** The most important persistent influence on the short-tailed albatross population is their near extinction due to commercial feather hunting. Conservation efforts have allowed the population to recover at or near to its biologically maximum rate. The total fishery-related mortality of short-tailed albatross is unknown, but it does not appear to be having an overriding effect on the population growth rate.

- **Reasonably Foreseeable Future External Effects.** The short-tailed albatross population may be substantially affected by several natural and human-caused mortality factors that may or may not occur in the future. These include volcanic eruptions on their main breeding site, Torishima Island, and increased rates of incidental take in fisheries throughout their range. If the species experiences a substantial increase in mortality that threatens its recovery, such increases may lead to further efforts to protect the species from fishery interactions.

- **Cumulative Effects.** Since the population of short-tailed albatross is susceptible to several natural and human-caused mortality factors that may or may not occur in the future, including incidental take in the groundfish fisheries under the PA, the cumulative effect on short-tailed albatross is considered to be conditionally significant adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects**. The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under both PA.1 and PA.2. This effect is considered insignificant at the population level for short-tailed albatross.

- **Persistent Past Effects.** Short-tailed albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to natural fluctuations in primary productivity and oceanographic factors. Pollution from a variety of land and marine sources has potentially affected short-tailed albatross prey in the past, but specific toxicological effects on forage fish populations are unknown.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on short-tailed albatross prey availability. Pollution is likely to affect short-tailed albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to short-tailed albatross, can not be made at this time.

- **Cumulative Effects**. Since the population decline of short-tailed albatross was caused by hunting rather than changes in habitat, and the habitat once supported millions of these birds, the population recovery of the species is not considered to be limited by food availability. The cumulative effect of all fisheries on the abundance and distribution of short-tailed albatross prey is considered to be insignificant at the population level.

Benthic Habitat

Since short-tailed albatross feed at the surface and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for short-tailed albatross.

4.9.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

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

The new seabird protection measures for longline vessels under PA.1 and PA.2 would be expected to result in a substantial reduction of incidental take of Laysan and black-footed albatross relative to the baseline condition (Melvin *et al.* 2001). In addition, as was the case with the longline hazzard research, research on the risk of incidental take of short-tailed albatross in trawl gear would likely be based on measured impacts of the much more common Laysan albatross. PA.1 would incorporate any mitigation measures for the trawl fleet that arise from this research if it appears to reduce the chances of incidentally taking short-tailed albatross. Potential future mitigation of take from trawl third wire collisions would therefore reduce incidental take of Laysan albatross and probably black-footed albatross as well. Under PA.2, scientific research would be used to develop practical and effective measures to further reduce incidental take of ESA-listed and other species on longline and trawl gear. Although reductions in take of Laysan and black-footed albatross would be used to evaluate the most effective techniques to protect short-tailed albatross, research on reducing take of other species could potentially yield additional benefits for the albatross species.

NOAA Fisheries recently finalized the new seabird deterrent regulations for the longline fleet that will be in effect for the 2004 fishing season (69 FR 1930). Most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season. Incidental take data from the 2002 season (NPFMC 2003b) indicates that estimated take of Laysan albatross in the BSAI longline fisheries declined from an average of 643 birds per year (1997-2001) to an estimated 48 birds per year in 2002. In the GOA longline fisheries, Laysan albatross take was reduced from an average of 124 birds per year (1997-2001) to 0 birds in 2002. In this same period, incidental take of black-footed albatross on BSAI longlines declined from an average of 11 birds per year to 0 in 2002. In the GOA, incidental take of black-footed albatross declined from an average of 156 birds per year to 33 birds in 2002. It should be noted that there are a number of factors that influence the number of birds that are caught in any one year besides the type of seabird avoidance measures that are used. These include the spatial and temporal distribution of fishing effort, weather, sea state, and previously observed inter-annual variations in overall food availability that appear to affect the intensity with which seabirds attack baited hooks. It may not be possible to ascertain how much different factors may have contributed to the reduced level of take in 2002 and it remains to be seen whether this reduced level of take will continue in the future. However, it is expected that fleet-wide compliance with the new regulations, which include equipment specifications and deployment standards, should result in a dramatic decline in take of albatross on longline gear.

Since the baseline level of incidental take from all groundfish fisheries is considered insignificant at their respective population levels for both Laysan and black-footed albatross, and incidental take of these species would likely be reduced under both PA.1 and PA.2, the overall effect of the PA.1 and PA.2 on incidental take of both albatross species is considered insignificant.

Availability of Food

Albatross forage over vast areas of ocean on prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections 4.5.4 and 4.5.10). Albatross are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under either PA bookend. Both PA.1 and PA.2 are considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under either PA bookend. Both PA.1 and PA.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on these albatross species are described in Sections 3.7.2 and 3.7.3 (Tables 3.7-6 and 3.7-7) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-53) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the new seabird protection measures for the longline fleet are expected to reduce incidental take of both albatross species. Mitigation measures for the trawl fleet may also be developed that would reduce incidental take of these species under both PA.1 and PA.2. Incidental take is considered insignificant at the population level for both species in this group.

- **Persistent Past Effects.** For black-footed and Laysan albatross, past mortality factors include large contributions from foreign longline fisheries and Hawaiian pelagic longline fisheries, smaller contributions from the BSAI/GOA longline and trawl fisheries, and unknown contributions from other longline fisheries (IPHC), other gear-type fisheries, and vessel collisions throughout their range. Both species have been experiencing population declines over the past decade. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment to mortality is unknown for both albatross species in this group.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets that are expected to reduce take of albatross in those fisheries. It is expected that incidental take of black-footed and Laysan albatross in foreign longline fisheries will remain high and will continue to exceed the threshold for population level effects.

- **Cumulative Effects.** Since the populations of black-footed and Laysan albatross are undergoing measurable declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under the PA.1 and PA.2, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under the PA.1 and PA.2. This effect is considered insignificant at the population level for both albatross species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on albatross prey populations can not be assessed at this time.

- **Persistent Past Effects.** Albatross primarily prey on squid species and small schooling fish that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Pollution from a variety of land and marine sources has potentially affected albatross and shearwater prey in the past. However, very little is known about the specific toxicological effects on prey species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a minimal effect on albatross prey availability. Pollution is likely to affect albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to albatross, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of albatross prey is considered to be insignificant at the population level for both species.

Benthic Habitat

Since albatross feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.9.7.3 Shearwaters

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

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

The new seabird protection measures for longline vessels (in effect as of the 2004 fishing season) are not effective for shearwaters because they are able to dive deeper than albatross and fulmars in pursuit of baited hooks (Melvin *et al.* 2001). Expected incidental take of shearwaters on longlines would therefore be similar to the baseline condition under PA.1. Under PA.2, additional research would be conducted to further reduce incidental take of all species on longline gear. This would likely include continued research into integrated weighted groundlines and other techniques which may prove effective for deterring diving birds such as shearwaters.

In the trawl sector, PA.1 would develop methods to reduce the risk of short-tailed albatross colliding with trawl gear. These efforts may also reduce the incidental take of shearwaters if they interact with trawl vessels in a similar manner. Under PA.2, additional research would be conducted to develop practical ways to reduce incidental take of non-ESA species in trawl gear. Since shearwaters are the second most commonly taken species group in trawl gear (after northern fulmars), they would likely receive substantial attention during development of potential mitigation measures under PA.2.

Since the baseline level of incidental take for these species is considered insignificant at their respective population levels and incidental take of these species could be reduced under both PA.1 and PA.2, the overall effect of the PA.1 and PA.2 on incidental take of both shearwater species is considered insignificant.

<u>Availability of Food</u>

Shearwaters forage over vast areas of ocean on planktonic prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections 4.5.4 and 4.5.10). Shearwaters are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under either PA bookend. Both PA.1 and PA.2 are considered to have insignificant effects on these species through availability of food.

<u>Benthic Habitat</u>

Shearwaters are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under either PA bookend. Both PA.1 and PA.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on sooty and short-tailed shearwaters are described in Section 3.7.6 (Table 3.7-14) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-54) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under PA.1, the new seabird protection measures for the longline fleet would be adopted but are not expected to reduce incidental take of shearwaters. Additional research and future mitigation measures could reduce incidental take of these species under PA.2. Mitigation measures for the trawl fleet under PA.1 and PA.2 may also reduce incidental take of shearwaters in the trawl sector. Expected incidental take is considered insignificant at the population level for both shearwater species.

- **Persistent Past Effects.** For sooty and short-tailed shearwaters, mortality factors include large contributions from subsistence and commercial harvest of chicks on the nesting grounds as well as climatic and oceanic fluctuations that cause periodic mass starvation, substantial contributions from foreign, Hawaiian, and BSAI/GOA groundfish longline and trawl fisheries, and a smaller contribution from vessel collisions throughout their range. It is difficult to assess the population trends in these abundant and widespread species, but there is some indications that both species may be declining. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment to mortality is unknown for both species in this group.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets that are similar to those proposed for the Alaskan fisheries. These measures are not expected to reduce incidental take of shearwaters in those fisheries. It is expected that incidental take of shearwaters in foreign fisheries will likely continue as in the past unless longline and trawl deterrence techniques are developed and applied that are effective for diving species.

- **Cumulative Effects.** Since the populations of shearwaters may be undergoing declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under PA.1 and PA.2, the cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally significant adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and plankton as bycatch under PA.1 and PA.2. This effect is considered insignificant at the population level for both shearwater species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on shearwater prey populations can not be assessed at this time.

- **Persistent Past Effects.** Short-tailed and sooty shearwaters are susceptible to periodic widespread food shortages that have caused massive die-offs in Alaskan waters. Natural fluctuations in primary productivity and oceanographic factors are considered to be the driving forces that determine the abundance of their main prey (euphausiids) rather than competitive interactions with other predators. Since shearwaters can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a minimal effect on shearwater prey availability. Pollution is likely to affect shearwater prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to shearwaters, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of shearwater prey is considered to be insignificant at the population level for all species.

Benthic Habitat

Since shearwaters feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for these species.

4.9.7.4 Northern Fulmar

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

Northern fulmars make up a majority of all birds taken in all three gear sectors. The numbers of fulmars taken are reported in the Observer Program data under their own species listing plus an unknown number of the unidentified tubenoses and unidentified seabird groups (Tables 3.7-1 through 3.7-5). The number of fulmars taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated number of fulmars taken in this period averaged 10,689 birds per year in the BSAI longline sector, 406 birds per year on GOA longlines, 3,083 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, and 42 birds per year in BSAI and GOA pots, for an estimated average identified take of 14,220 birds per year in the groundfish fishery. This total does not include any portion of the "unidentified seabird" category in the data set or any estimate of birds killed by vessel strikes. Given the high proportion of fulmars in the identified categories, one could reasonably assume that a large number of the unidentified bird remains were actually fulmars. For this analysis, the portion of unidentified birds in the data that were actually fulmars will be approximated as an additional 1,000 birds per year, mostly from the BSAI longline sector. Vessel strike data have been collected in an *ad hoc* manner but existing records indicate that an average of at least 80 fulmars are killed each year by trawl third wires. Adding these approximations to the identified fulmar takes gives a total estimated average take of about 15,300 birds per year from all fisheries. The latest population estimate for fulmars in the BSAI and GOA is about 2 million birds, with 4 to 5 million in the North Pacific (Hatch and Nettleship 1998). Mortality from the groundfish fishery is thus equal to about 0.76 percent of the BSAI and GOA population.

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

Since northern fulmars constitute the majority of birds taken incidentally in all sectors of the groundfish fisheries, they would likely benefit the most from improved seabird protection measures in both the longline and trawl fleets. Under PA.1, the new seabird protection measures would be expected to substantially reduce incidental take of fulmars from longlines, which accounts for much of the incidental take under baseline conditions. Most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season. Incidental take data from the 2002 season (NPFMC 2003b) indicates that estimated take of fulmars in the BSAI longline fisheries declined from an average of 10,689 birds per year (1997-2001) to an estimated 701 birds per year in 2002. In the GOA longline fisheries, fulmar take was reduced from an average of 406 birds per year (1997-2001) to 129 birds in 2002. As described above for albatross, many different factors may have contributed to the reduced level of take in 2002. However, it is expected that fleet-wide compliance with the new regulations, which include equipment and deployment standards, should result in a dramatic decline in take of fulmars on longline gear. Under PA.2, additional research into weighted groundlines and other techniques would likely further reduce incidental take of fulmars.

In the trawl sector, potential new mitigation measures to reduce the risk of collisions with short-tailed albatross would likely be based on measured reductions in take of other albatross and fulmars, as was done for the longline deterrence measures. New seabird protection measures for the trawl fleet under PA.1 would therefore likely reduce incidental take of fulmars. Under PA.2, additional research on reducing take of non-ESA species would also likely benefit fulmars since they are the most frequently taken species in trawl gear.

Incidental take of fulmars in longlines and trawl gear is expected to be greatly reduced from baseline levels under both PA.1 and PA.2. Since the baseline level of incidental take is already considered insignificant at the population level, the substantially reduced levels of take expected under the PA.1 and PA.2 are also considered insignificant at the population level. These reductions in take would greatly reduce concerns about potential colony level effects on the Pribilof Islands although the USGS/BRD would likely continue to investigate the issue.

Availability of Food

Fulmars forage over vast areas of ocean on prey that are taken in very small amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections, 4.5.4 and 4.5.10). Both PA.1 and PA.2 would continue to ban directed fishing on forage fish species and size classes and would develop ecosystem indicators for use in the TAC-setting process that would be intended to minimize potential adverse effects on non-target species. Fulmars are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under either PA bookend. Both PA.1 and PA.2 are considered to have insignificant effects on fulmars through availability of food.

Benthic Habitat

Fulmars are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under either PA bookend. Both PA.1 and PA.2 are considered to have no effects on fulmars through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on northern fulmars are described in Section 3.7.5 (Table 3.7-13) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-55 and summarized below.

Mortality

- **Direct/Indirect Effects.** Under the PA.1 and PA.2, the new seabird protection measures for the longline fleet would be adopted and potential mitigation measures for the trawl fleet would be developed. These measures are expected to substantially reduce incidental take of fulmars below the baseline level of incidental take such that mortality from incidental take would be considered insignificant at the population level.

- **Persistent Past Effects.** For northern fulmars, past mortality factors include large contributions from the BSAI/GOA groundfish fisheries and other net and longline fisheries in the North Pacific and Bering Sea. There is no indication of an area-wide population decline, but there is some concern that particular colonies may be experiencing declines. Other potential mortality factors that have been identified include acute and chronic effects of pollution, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation) due to climatic and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Incidental take of fulmars is expected to continue in all offshore fisheries in the BSAI/GOA. The IPHC fisheries will be subject to new seabird avoidance measures, so incidental take from the halibut and sablefish fleet is expected to decline substantially. Future oil spills and other incidents of pollution are likely, but their effects on fulmars will depend on many factors that can not be predicted.

- **Cumulative Effects.** Since the regional population of northern fulmars appears to be stable and the primary human-caused mortality factors, including contributions from the groundfish fisheries under PA.1 and PA.2, are expected to decline in the future, the cumulative effects on fulmars are considered to be insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch under both PA.1 and PA.2. This effect is considered insignificant at the population level for northern fulmars. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on fulmar prey populations can not be assessed at this time.

- **Persistent Past Effects.** Fulmars prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since fulmars can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected fulmar prey in the past. However, very little is known about the specific toxicological effects on species important to fulmars or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on fulmar prey availability. Pollution is likely to affect fulmar prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to fulmars, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of fulmar prey is considered to be insignificant at the population level.

Benthic Habitat

Since fulmars feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernible effect on their prey. Therefore, no cumulative effect is identified for this species.

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

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

The population of red-legged kittiwakes is estimated at around 150,000 birds, almost 80 percent of which nest on St. George Island in the Pribilofs. The combination of their restricted breeding area and substantial declines on permanent census plots led to their classification as a USFWS species of management concern. Red-legged kittiwakes have a separate species code in the Observer Program data on incidental take and may also be reported under the “gull” category and potentially under “unidentified seabirds” (Tables 3.7-1 through 3.7-5). Between 1993 and 2000, no specified red-legged kittiwakes were recorded as taken in any of the BSAI and GOA groundfish fisheries. One red-legged kittiwake was observed to be taken in a BSAI longline fishery in 2002, yielding an estimated 1-14 birds taken by the fleet. One red-legged kittiwake was found in an observer sample in a Bering Sea trawl in 2001 and one in 2002 (NPFMC 2003b). Because of different numbers and proportions of sampled hauls, these observed takes yielded estimated takes for the trawl fleet of 1- 37 birds in 2001 and 9-124 birds in 2002.

The new seabird avoidance measures for the longline fleet are expected to substantially reduce the incidental take of surface-feeding seabirds under PA.1. Since the incidental take of red-legged kittiwakes on longlines is apparently already very rare, a reduced level of take would be considered insignificant at the population level. Incidental take in trawl gear is also apparently rare and may or may not be reduced by potential mitigation measures that would be developed for the trawl fleet under PA.1 and PA.2. Since very few red-legged kittiwakes are likely to be taken in the groundfish fisheries under PA.1 and PA.2, the effect of this mortality is considered insignificant on the population-level.

Marbled and Kittlitz's murrelets are species of management concern in Alaska due to recent dramatic declines in their numbers in core habitats in southeast Alaska. Both of these species have separate species codes in the Observer Program data and may also be reported under the “alcids” and perhaps the “unidentified seabird” groups. No marbled or Kittlitz’s murrelets have been specifically reported taken in the observed groundfish fisheries between 1993 and 2001 (Tables 3.7-1 through 3.7-5). Given their nearshore preferences and non-gregarious behavior, it is unlikely that murrelets are taken regularly in any of the BSAI/GOA groundfish fisheries. Since alcids are taken so infrequently on longlines, seabird avoidance measures for longlines would likely not affect the incidental take of murrelets. Incidental take in trawl gear, if it occurs at all, may or may not be reduced by potential mitigation measures that would be developed for the trawl fleet under PA.1 and PA.2. Since the expected incidental take of marbled and Kittlitz’s murrelets approaches zero under the PA, this source of mortality is considered insignificant at the population level for both species.

Availability of Food

Red-legged kittiwakes consume several species of small schooling fish as well as zooplankton. Given the wide variety of foods used by red-legged kittiwakes and the extensive areas over which they forage, it seems unlikely that they would be susceptible to localized depletion of prey during the non-breeding season. During the breeding season, kittiwakes are more limited in their options and are more susceptible to localized depletions of prey around their colonies. They would be especially susceptible to prey depletions around the Pribilof Islands, where 80 percent of the population breeds. However, the species and size classes of forage fish and zooplankton that red-legged kittiwakes consume are taken only in negligible amounts as bycatch in the groundfish fisheries and the ban on directed fisheries on forage fish would remain in place under both PA.1 and PA.2. The abundance and distribution of kittiwake prey are not expected to be affected on an ecosystem level by the groundfish harvest under either PA.1 or PA.2 (see Forage Fish and Ecosystem Sections 4.9.4 and 4.9.10). PA.1 and PA.2 are therefore considered to have insignificant effects on the availability of food for red-legged kittiwakes.

Marbled and Kittlitz’s murrelets forage in shallow waters within 5 kilometers (km) of shore and feed on small fish such as capelin and Pacific sandlance as well as zooplankton and other invertebrates. The groundfish fisheries have very little spatial overlap with murrelet foraging areas and, as described above for kittiwakes, are expected to have insignificant effects on the abundance and distribution of their prey species. The overall effect of PA.1 and PA.2 on the availability of food for these species is considered insignificant at the population level.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish fishery management. Marbled and Kittlitz’s murrelets feed on species that depend on benthic habitats for at least part of their life cycles. However, benthic habitats in their nearshore foraging areas would not be affected directly by groundfish trawls under PA.1 and PA.2 as these would take place further offshore. Both PA.1 and PA.2 are considered to have insignificant effects on marbled and Kittlitz's murrelets and no effects on red-legged kittiwakes through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on red-legged kittiwakes, marbled murrelets, and Kittlitz's murrelets are described in Sections 3.7.13 and 3.7.17 (Tables 3.7-22 and 3.7-26), and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.5 (Table 4.5-56) and summarized below.

<u>Mortality</u>

- **Direct/Indirect Effects.** Under both PA.1 and PA.2, the incidental take of red-legged kittiwakes and both murrelets is expected to be rare and insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging (red-legged kittiwakes), incidental take in coastal salmon gillnet and other net fisheries (murrelets), oil spills (murrelets), logging of nest trees (marbled murrelets), and climatic warming that reduces glacial habitat (Kittlitz's murrelet). Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed very little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. For red-legged kittiwakes, the introduction of nest predators or a large oil spill around the Pribilof Islands in nesting season could have significant effects on mortality. For the murrelet species, oil spills in nearshore habitats and incidental take in salmon and other coastal net fisheries are likely to remain the largest factors in the future. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality. If the Kittlitz's murrelet population continues to decline and the species is listed under the ESA, new regulations may be placed on the various nearshore net fisheries to monitor and reduce incidental take of the species. These measures would also benefit marbled murrelets.

- **Cumulative Effects.** The three species in this group have all experienced substantial population declines in the recent past and are all susceptible to future human-caused mortality factors including potentially small contributions from the groundfish fishery. The decline of red-legged kittiwakes on the Pribilofs may have been reversed recently but it is not clear if their recovery will continue in the future. The cumulative effect for red-legged kittiwake is considered conditionally significant adverse at the population level through mortality. Both murrelet species continue to decline in their core areas and are thus considered to have significantly adverse cumulative effects at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all three species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All three species prey on small schooling fishes, and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, has likely affected the prey of these species in the past. Since murrelets are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded murrelets from certain important foraging areas and contributed to their population declines.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** While the groundfish fisheries are considered to have an insignificant effect on prey availability on their own, the dynamic interaction of natural and human-caused events, including fisheries and pollution, on the availability of forage fish and invertebrate prey to seabirds is only beginning to be explored with directed research. The potential roles of changes in food availability to the observed population declines in these species are still under investigation. Since this dynamic could conceivably be adverse or beneficial depending on different circumstances, the cumulative effect on prey availability is considered to be unknown for these three species.

Benthic Habitat

Since red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery, no cumulative effect is identified for this species through benthic habitat.

Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles, but they forage in shallow waters that are inshore of the groundfish fishery. Although a number of natural and anthropogenic factors may impact benthic habitat important to murrelet prey, fluctuations in prey abundance have not been implicated in the population declines of either species. The cumulative effects on both murrelet species through changes in benthic habitat, including a minimal contribution from the groundfish fisheries, are therefore considered insignificant.

4.9.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

The incidental take of species considered in this piscivorous group is reported in the Observer Program data under the gull, alcid, and "other" categories, as well as an unknown number of the "unidentified seabird" category (Tables 3.7-1 through 3.7-5). The number of piscivores taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001 data since these measures were implemented in 1997. The estimated number of gulls taken in this period averaged 3,268 birds per year in the BSAI longline sector, 147 birds per year on GOA longlines, and 274 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for an estimated average take of 3,689 birds per year in the groundfish fishery. Even if a large proportion of the unidentified seabirds are gulls, this level of mortality is considered insignificant at the population level given the combined estimated abundance (2.5 million birds) of the different gull species in the BSAI and GOA (Table 3.7-21).

For the alcids, mortality from the groundfish fishery comes almost entirely from the trawl sector and averaged 259 birds per year (mean of low and high estimates) in the BSAI/GOA trawls. Given the estimated abundance of large alcids in these waters (approaching 20 million, Table 3.7-21), this level of mortality is considered insignificant at the population level. The 3 cormorant species all live and feed in nearshore waters and would thus be unlikely to be taken in the groundfish fisheries. Incidental take of cormorants would be included in the "other" category, which approaches zero and is therefore considered an insignificant source of mortality at the population level.

Under PA.1, the new seabird protection measures for the longline fleet would be expected to result in a substantial overall reduction in take of surface-feeding species such as gulls. Under PA.2, additional research into weighted groundlines and other techniques would also likely reduce take of gulls. These species may also benefit from reduced take in the trawl sector due to potential mitigation measures for the trawl fleet under both PA.1 and PA.2. Trawl gear protection measures would have more potential to reduce incidental take of alcids than any modifications to longline techniques because alcids are taken mostly in trawl gear. Since the baseline level of incidental take from all gear types is already considered insignificant at the population level for gulls and alcids, reduced levels of take under PA.1 and PA.2 are expected to have insignificant effects on piscivorous species through incidental take.

Availability of Food

Foraging success by piscivorous seabirds depends not only on the biomass of forage stocks in their feeding areas, but also on the availability of these stocks to the birds. The availability of prey is affected by a number of oceanographic and biological factors (see Section 3.7.1) that may vary substantially over short time periods and distances. The question of whether the intensity and structure of the groundfish fishery under the baseline condition has adverse or beneficial effects on the availability of forage fish for seabirds has not been addressed through directed research. Many of the data gaps identified in Section 5.1.2.8 address this issue. Although there are very little empirical data on how a fishery might affect the availability of forage fish to seabirds, it is assumed that fishing (with trawl gear at least) could disrupt the movements and structure of forage fish schools such that they would be less available to seabirds, at least for a short period of time. Localized depletion or disruption of prey species around seabird colonies could be particularly detrimental during the chick-rearing period for breeding seabirds. However, most of the groundfish fisheries are conducted during the non-summer months, with minor overlap in the late spring and early fall months. In addition, many species can forage up to 40 km from their colonies during chick-rearing with a few species ranging to 100 km so any localized and short term disruptions of forage fish would have minimal effects at the population level. The species and size classes of forage fish (and zooplankton) that piscivorous seabirds feed on are taken only in negligible amounts as bycatch and incidental take by the groundfish fisheries. The groundfish harvest does not appear to be "fishing down the food web" or otherwise affecting seabird prey on an ecosystem level (see Ecosystem, Section 4.5.10). The existing ban on the development of a commercial forage fish fishery (BSAI/GOA FMP Amendments 36/39) is considered to be beneficial to seabirds by preventing a potentially adverse fishery from developing. This ban would be maintained under both PA.1 and PA.2.

The fisheries provide an artificial yet nutritious supplement to seabird diets in the form of processing waste and offal. No studies have been conducted in Alaska on whether this food source provides a significant benefit to the survival rate or reproductive success of any species on the population or colony level. It is likely that the value of this supplemental food varies over time and space, fluctuating with the availability of natural food supplies and seasonal nutritional needs. Whereas some birds may benefit from the food supply provided by offal and processing waste, such waste also acts as an attractant that may lead to increased incidental take in fishing gear. In addition, some species, such as the large gulls, tend to be more successful at competing for fish scraps at vessels and processors and may thus receive a greater nutritional boost than the smaller species. Since the large gulls are also nest predators of other species, especially kittiwakes and murres, the supplemental food from fishery wastes may be beneficial to some species and detrimental to others within this species group. Thus, this indirect effect of the fishery potentially has both beneficial and adverse effects on seabirds and the net benefit or liability is unknown. Under PA.1 and PA.2, the contribution of the fishery to the food supply of gulls in the form of fishery discards would be about the same as the baseline or reduced as a result of bycatch reduction and IR/IU measures.

Population trends and reproductive success rates of most piscivorous species in the BSAI/GOA are mixed, with some species and colonies doing well in some areas and years while the same species show declines and breeding failures in other locations and years (Dragoo *et al.* 2001). Although some species are susceptible to periodic die-offs due to starvation, natural fluctuations in ocean currents and climatic variables could account for many of these episodes. There is no evidence that populations of the piscivorous seabirds considered in this group have been experiencing consistent or area-wide declines in productivity. Since the structure and intensity of the fisheries under PA.1 and PA.2 would be similar or reduced in scope from existing conditions, the potential impact of the fisheries on piscivorous seabirds through prey availability would be similar to the baseline condition and would be considered to be insignificant at the population level for all piscivorous seabirds.

<u>Benthic Habitat</u>

Cormorants and alcids have diverse diets that include both small schooling fishes (capelin and sand lance) as well as demersal fish species and crustaceans. These birds are capable of diving from 40 m to over 100 m deep and are thus able to reach the ocean floor in many areas. Some species, such as cormorants and guillemots, usually forage in coastal waters during the breeding season, but other species forage well away from land. Bottom trawl gear has the greatest potential to indirectly affect these diving seabirds via physical changes to benthic habitat but pelagic trawls (to various extents), pot gear, and longline gear also contact the ocean floor. Trawling (and to a lesser extent other fishing gear disturbance) can reduce habitat complexity and productivity (NRC 2002). Specific effects of trawling on seabird prey species in the BSAI/GOA (through habitat change rather than by direct take) are poorly known (see Sections 3.6 and 5.1.2.7 on EFH for a discussion of research needed to address data gaps in benthic habitat changes due to trawling). However, none of the species in this group appear to have experienced consistent or widespread population declines so there is no indication that the carrying capacity of the environment has been decreased through changes to benthic habitat (or any other mechanism). Overall trawl effort in the BSAI/GOA relative to the baseline conditions is predicted to be similar under PA.1 and reduced under PA.2. The effects on piscivorous seabirds through potential changes in benthic habitat are therefore considered insignificant at the population level.

Cumulative Effects of PA.1 and PA.2

The past/present effects on the species in this group, including most alcids, gulls, and cormorants, are described in their species accounts in Section 3.7 (Tables 3.7-16 and 3.7-20) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-57 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of surface-feeding piscivores is expected to decrease due to new seabird protection measures for the longline fleet. Incidental take of diving species may also be reduced if new mitigation measures are developed and implemented for the longline and trawl fleets under PA.2. The incidental take for all species in this group is expected to be insignificant at the population level under both PA.1 and PA.2.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging, incidental take in a variety of foreign and U.S. coastal and pelagic fisheries, oil spills and other pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e., rats) to seabird colonies. Conservation concerns focus on preventing potential impacts around breeding colonies during the nesting season since populations are concentrated in time and space. For some species, human impacts in nearshore habitats will likely have a much greater effect on their populations than offshore fisheries. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch and incidental take. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All species in this group prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources has likely affected the prey of these species in the past. Since some of the alcids are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded them from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute to the dynamic interaction of natural and human-caused events that affect the availability of forage fish and invertebrate prey to seabirds. While this dynamic is only beginning to be explored with directed research, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under PA.1 and PA.2, the cumulative effect on prey availability is considered insignificant at the population level for these species.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, have the potential to modify benthic habitats and have indirect effects on the food web of diving piscivorous species. The overall effects on piscivorous seabirds through potential changes in benthic habitat are considered insignificant.

- **Persistent Past Effects.** Benthic habitats important to the diving species in this group have been affected by various foreign and U.S. fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated, so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to seabirds. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may have persistent effects in certain areas.

- **Reasonably Foreseeable Future External Effects.** All future fisheries in the BSAI/GOA that use bottom contact fishing gear are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will continue.

- **Cumulative Effects.** The groundfish fisheries contribute to the many human-caused and natural factors that alter benthic habitats important to the food web of piscivorous seabirds. While there has been limited research on specific effects of benthic habitat disturbance on seabirds, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new external contributing factors are expected in the future and the intensity of trawling is expected to remain the same under PA.1 and be reduced under PA.2, the cumulative effect on benthic habitat is considered insignificant at the population level for these species.

4.9.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

Leach's and fork-tailed storm-petrels are not identified to species in the Observer Program data but they do have an"unidentified storm-petrel" code and may be reported in the "unidentified tubenoses," "other," and "unidentified seabird" categories (Tables 3.7-1 through 3.7-5). The numbers of storm-petrels in these categories are unknown but likely to be small given their feeding behavior. Given the abundance of these species in the BSAI/GOA area, with a combined population estimate of over 10 million birds (Table 3.7-21), incidental take of storm-petrels under the baseline conditions is considered to be insignificant at the population level. Although some of the planktivorous auklets have individual species codes in the Observer Program data, they are reported in the "alcid" and "unidentified seabird" categories. It is unlikely that they are taken on longlines at all and probably constitute only a small fraction of the trawl take. Given their abundance in the BSAI/GOA, with a combined population of over 10 million birds (Table 3.7-21), incidental take of auklets under the baseline conditions is considered to be insignificant at the population level.

Under the PA.1 and PA.2, new seabird avoidance measures would be expected to reduce incidental take of surface-feeding and diving seabird species from both longlines and trawls. Since the incidental take of these species is considered to be insignificant under the baseline conditions, reduced levels of take would also be considered insignificant. The effects of both PA.1 and PA.2 on incidental take of planktivorous species are therefore considered to be insignificant at the population level.

Another means of incidental take in the fishery is by birds striking the vessel or rigging. The Observer Program does not record vessel strikes on a systematic basis so data on the frequency or extent of such strikes are very limited (NPFMC 2003b). Crested auklets do not seem to strike fishing vessels very frequently but when they do, the incidents often involve large numbers of birds. According to preliminary analysis of the observer records of bird-strikes from 1993-2000, 1,305 crested auklets were involved in 7 recorded collisions. In one historical account, approximately 6,000 crested auklets were attracted to lights and collided with a fishing vessel near Kodiak Island during the winter of 1977 (Dick and Donaldson 1978). Storm-petrels are also prone to periodic collisions involving many birds (631 birds in 19 recorded incidents). Bird strikes are probably most numerous during the night and during storms or foggy conditions when bright deck lights are on, which can cause the birds to be disoriented. Given the sporadic nature of these collisions and the small numbers of birds involved relative to their overall populations, the effect of the fisheries on these species through vessel collisions is considered insignificant at the population level under the baseline conditions. Since fishing effort under PA.1 and PA.2 would be similar to the baseline or reduced, the effect of PA.1 and PA.2 on incidental take from vessel collisions is considered insignificant.

Availability of Food

Storm-petrels are relatively small surface feeding seabirds that primarily target zooplankton and juvenile fish. The auklets feed on zooplankton (euphausiids), juvenile fish, and squid. The abundance and distribution of these prey species are affected by a number of oceanographic and biological factors (see Section 3.7.1) that may vary substantially over short time periods and distances. The groundfish fisheries could indirectly affect the availability of zooplankton and small schooling fish to seabirds through changes in the abundance and distribution of target fish species that also prey on small fish and zooplankton. For example, since young pollock are planktivores, large changes to pollock populations as a result of fishing could theoretically affect the carrying capacity for storm-petrels and auklets. However, zooplankton and juvenile fish abundance and distribution are thought to be influenced much more by primary productivity and oceanographic fluctuations (bottom-up factors) than predator/prey relationships (top-down factors) (see Section 4.5.10). Since the structure and intensity of the fisheries managed under PA.1 and PA.2 would be similar or reduced relative to the baseline, the effect of PA.1 and PA.2 on prey availability for planktivores is considered insignificant at the population level.

Benthic Habitat

Storm-petrels and auklets are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish management. The PA.1 and PA.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on the species in this group, including storm-petrels and most auklets, are described in Sections 3.7.7 and 3.7.18 (Tables 3.7-15 and 3.7-27) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-58 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of the species in this group is expected to remain sporadic in occurrence and affect relatively few individuals and is considered to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in foreign and U.S. coastal and pelagic fisheries, oil spills and other marine pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e., rats) to seabird colonies. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including small contributions of incidental take from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch. Indirect effects on zooplankton and juvenile fish abundance through changes in the abundance of target fish predators is considered minor compared to seasonal changes in primary productivity and oceanographic factors. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** Factors that have affected the abundance and distribution of zooplankton and juvenile fish include bycatch in squid and forage fish fisheries, marine pollution, and the decimation of planktivorous whales by commercial whaling. These effects are considered minor compared to seasonal and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have minimal effects on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute in an indirect way to human influences on planktonic prey availability, and are considered minimal compared to natural fluctuations. These cumulative effects are considered insignificant on the population level for all species in this group.

Benthic Habitat

Since these planktivorous seabirds feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for these species.

4.9.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

Spectacled eiders interact very little, if at all, with the groundfish fisheries because most of the habitat for this species is located in the northern Bering Sea or in inshore areas of northwest Alaska. There is therefore very little opportunity for the groundfish fisheries to affect spectacled eiders through mortality. Although spectacled eiders have an individual species code in the Observer Program manual, no spectacled eiders have been observed to be taken in any of the fisheries since data collection began in 1993. In the most recent ESA Section 7 consultation (USFWS 2003a, USFWS 2003b), the USFWS concluded that the groundfish fisheries had negligible impacts on the population recovery or critical habitat of spectacled eiders.

The winter distribution of Steller's eiders does include areas where groundfish fisheries occur although these birds prefer shallow, nearshore waters. There is some overlap between the fisheries and Steller's eider critical habitat in the northwestern portion of Kuskokwim Bay (Kuskokwim Shoals). Only two vessels fished this area in 2001, both over 200 ft LOA so there was 100 percent observer coverage. Steller's eiders have an individual species code in the Observer Program manual but no incidental takes have been documented since 1995 (Tables 3.7-1 through 3.7-5).

Under the PA.1 and PA.2, NOAA Fisheries would continue to consult with USFWS to protect all threatened or endangered species from potential adverse effects of the groundfish fishery. PA.1 and PA.2 are not expected to change the distribution of the groundfish fisheries to the point that they overlap with the distribution of spectacled eider habitat and are therefore considered to have no effects on spectacled eiders through incidental take. Incidental take of Steller's eiders in fishing gear already approaches zero under the baseline conditions so it is unlikely that new longline or trawl mitigation methods would yield substantial benefits for the species or be implemented on their behalf. The primary danger would appear to be the risk of collisions with all vessels, especially as birds are attracted to deck lights under poor visibility conditions. Minimizing the amount of light directed out to sea may help mitigate this risk. Based on the very minimal overlap between the predicted fisheries and Steller's eider, including only the Kuskokwim Shoals area, incidental take under the PA.1 and PA.2 will likely remain at levels approaching zero and is considered to have insignificant effects on the populations of this species through incidental take.

Availability of Food

The abundance of marine invertebrate species important to the spectacled and Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. The groundfish fisheries catch only negligible amounts of these species and are unlikely to affect their abundance or distribution through ecosystem level effects under the baseline conditions (see Section, 4.5.10). As discussed above, there is essentially no overlap between the groundfish trawl fisheries and spectacled eider habitat under the baseline conditions. PA.1 and PA.2 are not expected to change this situation and are considered to have no effects on spectacled eiders through prey availability. Under both PA.1 and PA.2, there would be very little overlap between the groundfish fisheries and foraging areas for Steller's eiders, so the direct take of eider prey through bycatch would be negligible. The effects of the groundfish fisheries on prey abundance and availability (through direct take rather than habitat disruption) are considered insignificant at the population level for this species.

Benthic Habitat

Gear impacts on benthic habitat used by spectacled and Steller's eiders would primarily be from bottom trawl gear although pelagic trawls and pot gear also make contact with the bottom and contribute to benthic disturbance. Trawling (and to a lesser extent other fishing gear disturbance) can reduce habitat complexity and productivity (NRC 2002). The effects of trawl gear on benthic habitat are discussed in the habitat sections of this document (Sections 3.6.4 and 4.5.6).

Based on an analysis of the Observer Program data, no overlap occurred between spectacled eider critical habitat and the groundfish fishery under the baseline conditions. As discussed above, there is essentially no overlap between the groundfish trawl fisheries and spectacled eider habitat under the baseline conditions. The PA.1 and PA.2 are not expected to change this situation and are considered to have no effects on spectacled eiders through benthic habitat changes.

Since Steller's eiders forage almost exclusively in shallow waters inshore of the groundfish fisheries, their preferred winter habitats are not subject to groundfish fishing effort. During the breeding season, the overlap of bottom trawl fisheries and Steller's eider critical habitat is also very limited, involving only a few vessels in a limited area of Kuskokwim Bay (NPFMC 2003b). The effects of this small bottom trawl fishery on Steller's eider critical habitat have not been investigated but considering the limited fishing effort and large area of critical habitat that is not fished, it is unlikely that the changes in benthic habitat resulting from this fishery would affect Steller's eiders on a population level. During Section 7 consultations with NOAA Fisheries, USFWS also concluded that the fisheries were not likely to adversely affect Steller's eider critical habitat or their food supply through bottom-contact fishing gear (USFWS 2003a). For Steller's eiders, trawl effort in their critical habitat is limited to Kuskokwim Shoals under the baseline conditions. The small amount of fishing in this area is limited by logistical considerations and lack of interest by the fleet. No changes in management under the PA.1 and PA.2 would lead to an increase use of this area or any other foraging area. Potential effects are likely to remain similar to the baseline condition, which are considered insignificant. The overall effect of the PA.1 and PA.2 on the benthic habitat of Steller's eider is considered to be insignificant at the population level.

Cumulative Effects of PA.1 and PA.2

The past/present effects on spectacled and Steller's eiders are described in Sections 3.7.9 and 3.7.10 (Tables 3.7-17 and 3.7-18) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-59 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of spectacled and Steller's eiders is expected to be similar to the baseline condition and is considered to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include sport hunting and subsistence harvest in Russia and Alaska, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution that causes physiological stress and reduces survival rates, lead shot poisoning on the nesting grounds, and collisions with vessels and other structures. Incidental take in the BSAI/GOA groundfish fisheries appears to have been very rare for Steller's eider. Both species have been afforded protection through the ESA.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns focus on preventing potential impacts in critical habitat areas.

- **Cumulative Effects.** The groundfish fisheries do not contribute to direct mortality of spectacled eiders, so no cumulative effect is identified for that species. Decreased adult survival rates appear to have driven the past population decline of Steller's eiders. Known sources of direct human-caused mortality of Steller's eider, including very rare incidental take in the groundfish fisheries, do not appear to account for the past population decline in Alaska. However, several indirect factors may be contributing to decreased adult survival rates, including climate-induced changes in habitat, concentration of predators around nesting areas due to nearby human habitation, and pollution of nearshore waters from chronic and periodic sources of petroleum products (USFWS 2003a). Since the Alaska breeding population of Steller's eiders has declined dramatically in the past and has not recovered, and because several human-induced sources of mortality have been identified as potential contributing factors to this decline, including the potential for contributions to pollution and vessel collisions from the groundfish fisheries as managed under PA.1 or PA.2, the cumulative effects of mortality on Steller's eiders are considered significant adverse at the population level.

Changes in Food Availability

There is no overlap predicted between spectacled eider critical habitat and the groundfish fisheries; therefore, no cumulative effects have been identified under PA.1 or PA.2. The abundance of marine invertebrate species important to Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. Although anthropogenic factors may affect eider prey in limited locations, including chronic sources of pollution near harbors, natural factors such as seasonal, tidal, and oceanographic fluctuations are considered to play a dominant role in determining the abundance and distribution of eider prey. The cumulative effects associated with the groundfish fisheries and other human activities are therefore considered to have insignificant effects on prey availability for Steller's eiders.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, disrupt benthic habitats that support the prey of eiders. Under PA.1 and PA.2, the groundfish fishery is not expected to occur in spectacled eider critical habitat or any other area that they typically use; therefore, no effects have been identified. A limited amount of bottom trawling is expected to overlap with Steller's eider critical habitat. The overall effects of PA.1 and PA.2 on Steller's eiders through potential changes in benthic habitat are considered insignificant at the population level.

- **Persistent Past Effects.** Benthic habitats important to spectacled and Steller's eiders have been affected by various trawl and pot fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated, so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to eiders. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may have persistent effects in certain areas. Climate change and ocean temperature fluctuations may also play a role in altering the benthic environment.

- **Reasonably Foreseeable Future External Effects.** All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects.** There is no overlap predicted between spectacled eider critical habitat and the groundfish fisheries; therefore, no cumulative effects on benthic habitat have been identified for this species. While the groundfish fisheries are predicted to have little spatial overlap with Steller's eider habitat under PA.1 or PA.2, the interaction of all human-caused and natural disturbances on benthic habitat important to Steller's eiders has not been examined with respect to their population declines in the past. The cumulative effects of benthic habitat disruptions and changes over the years as they relate to the food web important to Steller's eiders are considered to be unknown.

4.9.8 Marine Mammals Preferred Alternative Analysis

4.9.8.1 Western Distinct Population Segment of Steller Sea Lions

Direct/Indirect Effects PA.1 – Western Distinct Population Segment of Steller Sea Lions

<u>Incidental Take/Entanglement in Marine Debris</u>

The analysis used to determine changes in the level of incidental takes described in Section 4.5.8 was applied to establish the significance of incidental take and entanglement of marine mammals expected to occur under each FMP. Regarding incidental take, PA.1 is not likely to result in significant changes to the population trajectory of the western distinct population segment (western population) of Steller sea lions. An average of 8.4 Steller sea lions from the western population was estimated to have been taken incidental to groundfish fisheries from 1995-1999 (Angliss *et al.* 2001) (Table 4.5-60). The ratio of observed takes of Steller sea lions to observed groundfish catch (from 1995 to 1999) was multiplied by the new projected groundfish catch (all fisheries combined) to estimate incidental takes expected to occur over the next six years under this alternative management regime. The estimated annual incidental take level of Steller sea lions under PA.1 in all areas combined is expected to be less than ten based on expected catch in this FMP, or about one sea lion per 220,000 mt of groundfish harvested.

Incidental bycatch frequencies in the BSAI, which are typically low, reflect locations where fishing effort was highest. In the Aleutian Islands and GOA, incidental takes are often within critical habitat, though in the Bering Sea such bycatch is farther offshore and along the continental shelf. Otherwise there seems to be no apparent "hot spot" of incidental catch disproportionate with fishing effort. Therefore, it is appropriate to estimate the take ratios based on estimated catch. However, if these take rates differ between observed and unobserved vessels then these take estimates would be biased accordingly. These rates also reflect a prohibition of trawling within 10 or 20 nm of 37 rookeries which likely reduces the potential for incidental take, particularly during the breeding season when females are on feeding trips within the critical habitat area.

Entanglement of sea lions in derelict fishing gear or other marine debris does not appear to represent a significant threat to the population. From a sample of rookeries and haul-out sites in the Aleutian Islands in which 15,957 adults were observed, Loughlin *et al.* (1986) found only 11 (0.07percent) entangled in marine debris, sone of which was derelict fishing gear. Observations of sea lions at Marmot Island for several months during the same year observed two out of 2,200 adults (0.09 percent) entangled in marine debris. Between 1993 and 1997, only one fishery-related stranding was reported from the range of the western populations: a sea lion observed in August 1997 with troll gear in its mouth and down its throat (Angliss *et al.*2001). Entanglement of sea lions in derelict fishing gear or other marine debris does not appear to present a significant threat to the populations. In conclusion, incidental take and entanglement in marine debris under PA.1 is insignificant according to the criteria set for significance (Table 4.1-6).

The Marine Mammals Protection Act (MMPA) requires NOAA Fisheries (NMFS Office of Protected Resources) to assess whether human-caused mortality threatens the stability or recovery on any species of marine mammal. The MMPA defines a measurement tool fo this purpose, the potential biological removal (PBR), that is a calculated value of the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. This calculation takes into consideration the most recent population estimates, historic population trends, status of the stock in relation to historic levels (i.e., whether it is depressed or not), and potential rates of recovery. According to the most recent stock assessment, PBR for the western population of Steller sea lions is 208 animals per year (Angliss and Lodge 2002). Mortality from incidental take an entanglement in marine debris is likely to continue under PA.1 at levels that are small (less than 10 percent) relative to PBR and is therefore considered insignificant according to the criteria set for significance (Table 4.1-6).

<u>Fisheries Harvest of Prey Species</u>

Changes in the fishing mortality rate for Steller sea lion prey species were calculated using output from the Multi-species Management Model which projected catch rates for the various FMPs. The estimated fishing mortality rates expected to occur under each FMP management regime were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining the effects on marine mammal populations. The baseline fishing mortality rates for the individual BSAI and GOA groundfish fisheries, the fishing mortality rates projected to occur under each alternative FMP, and the relative difference between the baseline and alternative fishing mortality rates are shown in Table 4.5-61.

Under PA.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 23 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in harvest of this key Steller sea lion prey species is considered significantly adverse. It is worth noting that the harvest rate of pollock in the EBS was abnormally low in 2002. This low harvest rate was due to the high abundance or commercially sized pollock in the EBS which resulted in a large recommended ABC for this population, By definition ABC is set annually at a level deemed to be biologically acceptable based on the status and dynamics of the population, environmental conditions, and other ecological factors (e.g., natural mortality). The baseline groundfish FMPs contain catch provisions referred to as OYs that limit the total amount of BSAI and GOA groundfish harvest. Unlike the ABC, which is applied to individual species or species groups, the OY limit applies to the entire complex of commercially important species as well as other species with lesser or no commercial importance in each management region, In 1981, the OY for total BSAI groundfish catch was set as a range from 1.4 to 2.0 million mt. In 2002, the recommended ABC for pollock in the EBS was greater than the OY ceiling and was therefore capped to stay within the OY range. Because the 2002 EBS pollock TAC was capped by the OY ceiling, F was lower than that deemed to be biologically acceptable. Therefore, in relative terms, subsequent increases in F expected to occur under PA.1 for EBS pollock may not result in significantly adverse effects to predators in terms of the biomass of prey available, despite being categorized as such under the established significance criteria. The harvest of EBS pollock under the PA.1 management regime meets the criteria of a significantly adverse impact to Steller sea lions, although the actual effects are likely insignificant due to the low fishing mortality under the baseline.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 23 percent relative to the comparative baseline over the next five years under PA.1. This change in the fishing mortality rate is significantly beneficial for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. There is no change in the projected catch of Aleutian Islands pollock between the baseline and PA.1 and therefore effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level.

Under PA.1, the BSAI Pacific cod fishing mortality rate is expected to decrease by 19 percent. This change is determined to be insignificant to Steller sea lions according to the criteria established in Table 4.5-61. Under PA.1, the GOA Pacific cod fishing mortality rate is expected to increase by 19 percent which was determined to be insignificant to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with an expected increase in the fishing mortality rate of 60 percent relative to the baseline under PA.1.

Little difference is expected relative to the baseline and among the alternatives for the harvest of other and non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions.

The comparative baseline conditions include all Steller sea lion protection measures that were adopted in 2001 (NMFS 2001a). These measures would be retained under PA.1 and include provisions to protect prey resources such as area closures, critical habitat harvest limits on prey species, gear and TAC restrictions, and a modified global harvest control rule to prohibit fishing when spawning biomass per recruit is reduced to 20% of the unfished level. With these controls, the combined harvest of prey was found to not jeopardize the continued existence of the western populations of Steller sea lions (NMFS 2001a). While ratings for harvest of individual prey species range from significantly beneficial to significantly adverse, overall harvest levels under PA.1 would be similar to the 2002 baseline conditions and are thus considered insignificant to the western population of Steller sea lions.

Spatial and Temporal Concentration of the Fishery

The criterion used to evaluate the spatial and temporal effects of the groundfish fisheries on marine mammal populations is that the FMP would be expected to result in either increased or decreased spatial and temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. The spatial/temporal measures under the baseline conditions were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods that are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities; e.g., surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interactions between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures, yet where sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as global controls. Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the western population of Steller sea lions in the wild. Spatial and temporal fishing measures in PA.1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under PA.1 are determined to be insignificant to Steller sea lions according to the criteria established in Table 4.1-6.

Disturbance

With regard to disturbance, existing management measures are designed to reduce nearshore disturbance of Steller sea lions. In particular, the prohibition of vessel entry within 3 nm of major rookeries avoids intentional and unintentional hazing of hauled out sea lions or those aggregated near shore. A total of 3,250 square kilometer (km^2) around 36 sites is offered this protection.

It is not clear what might constitute adverse disturbance elsewhere, such as in pelagic foraging areas. Vessel traffic, nets moving through the water column, or underwater sound production may all represent perturbations, which could affect foraging behavior, but few data exist to determine their relevance to Steller sea lions. The influence of trawl activities on Steller sea lion foraging success can not be addressed directly with existing data. Foraging could potentially be affected not only by interactions between vessels and sea lions, but also as a function of changes in fish schooling behavior, distributions or densities in response to harvesting activities. In other words, disturbance to the prey base may be as relevant a consideration as disturbance to the predator itself.

For the purposes of this analysis, it is recognized that some level of prey disturbance may occur as a fisheries effect. The impact on marine mammals who prey on fish schools is a function of both the amount of fishing activity and its concentration in space and time, neither of which may be extreme enough under the status quo to represent population level concerns. To the extent that the baseline condition imposes limits on fishing activities inside critical habitat, it is assumed some protection from these disturbance effects is currently provided. These protections occur as byproducts of other actions that either reduce fishing effort or create buffer zones to limit impacts on foraging. With these measures in place, the baseline is consistent with the underlying goal of reducing disturbance effects.

Anecdotal evidence suggests that fisheries/disturbance related events are unlikely to be of consequence to the Steller's population as a whole. For instance, vessel traffic and underwater sound production have long been features of the Bering Sea and GOA, at least over much of the twentieth century. Such circumstances have prevailed before, as well as after the decline of Steller sea lions, suggesting no obvious causal link. Steller sea lions also appear to be tolerant of at least some anthropogenic effects, recognizing their attraction to fish processing facilities and gillnets as well as their distributions in proximity to ports. Further, the eastern population of Steller sea lions is increasing, despite anthropogenic activities throughout their range on the west coast of North America and particularly in southeast Alaska. The management regime under PA.1 is not expected to result in increased disturbance to Steller sea lions relative to the baseline and are therefore rated insignificant.

Cumulative Effects PA.1 – Western Distinct Population Segment of Steller Sea Lions

The past/present effects on the western population of the Steller sea lions are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects bring change in prey availability and change in the spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The level of mortality resulting from incidental take and entanglement in marine debris under PA.1 occurs at frequencies that do not have population level effects on the western population of Steller sea lions and is therefore considered insignificant.

- **Persistent Past Effects**. Substantial mortality of Steller sea lions did not occur in the fisheries until after the 1950s. The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period is not complete (Perez and Loughlin 1991). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996-2000. The number of Steller sea lions incidentally taken by state-managed nearshore salmon gillnet fisheries and halibut longline fisheries estimated 14.5 sea lions per year in the PWS drift gillnet fisheries (Wynne et al. 1992). It is thought that shooting used to be a significant source of mortality prior listing the Steller sea lion as endangered under the ESA. Two cases of illegal shooting were prosecuted in the Kodiak area in 1998 involving two Steller sea lions from the western population (Angliss et al. 2001). The subsistence harvest in western stock has decreased from over the last ten years from 547 to 171 animals per year (1992-1998) (Angliss and Lodge 2002). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick et al. 1987). Predation by transient killer whales and sharks has always contributed to the natural mortality of Steller sea lions, but the numbers of sea lions taken and the relative contribution of this factor to the recent population decline and lack of recovery is currently under investigation (Matkin *et al.* 2001, Matkin *et al.* 2003, Springer *et al.* 2003).

- **Reasonably Foreseeable Future External Effects**. Incidental take in the state-managed fisheries such as salmon gillnet fisheries will continue in the foreseeable future, but the numbers of Steller sea lions will likely be relatively low (less than ten per year). Entanglement and intentional shootings would be expected to continue at a similar level to the baseline condition. Pollution is unlikely to be a significant contributor to western Steller sea lion mortality due to its isolation from population centers. Predation will continue to contribute to natural mortality, but climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects**. The cumulative effect of mortality based on the contribution of internal effects of the groundfish fishery under PA.1 and external mortality factors is considered significantly adverse for the western population of Steller sea lions. The western population of Steller sea lions has declined approximately 80 percent since the 1970s and was listed as endangered under the ESA in 1997. A number of human-caused mortality factors have been identified as potentially contributing to this decline and lack of recovery. According to current estimates, incidental take from the BSAI and GOA groundfish fisheries and other fisheries (29 individuals) and subsistence harvest (198 individuals), exceeds the PBR (208 individuals) for the western population of Steller sea lions (Angliss and Lodge 2002). In addition, natural mortality factors such as predation by transient killer whales and sharks, may be relatively more important for a depressed population and may be inhibiting the recovery of the Steller sea lion population. Since the population is still depressed from historic levels and has not recovered to the point that a recovery rate can be reliably calculate, and because overall human-caused mortality exceeds the PBR for this population, the cumulative effect of all mortality factors is considered significantly adverse for the western population of Steller sea lions. The contribution of the groundfish fisheries under PA.1 is expected to be small compared to total human-caused mortality and to be similar to the baseline level, which has been determined not to jeopardize the continued existence or recovery of the western population under the ESA (NMFS 2001a).

Prey Availability

- **Direct/Indirect Effects.** The harvest of Steller sea lion prey species by the groundfish fisheries under PA.1 is similar to the baseline condition and is expected to result in insignificant population-level effects to Steller sea lions.

- **Persistent Past Effects**. Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State of Alaska waters, and partial overlap with other state-managed fisheries. These species were targeted in the past foreign and JV groundfish fisheries. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries, perhaps in conjunction with climate and oceanographic fluctuations, greatly reduced the availability of forage fish to Steller sea lions. NMFS has issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat, with most of the focus on the western population. The most recent Steller sea lion BiOp and EIS (NMFS 2001b and 2001c) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline conditions. New fisheries in State of Alaska or federal waters are not anticipated. Climate changes and regime shifts were identified as potential effects on the availability of prey, but the direction or magnitude of these changes are difficult to predict. Climate induced changes have been suspected in the decline of the western Steller sea lion population.

- **Cumulative Effects**. The cumulative effect on prey availability for Steller sea lions is based on direct, indirect, and external effects on prey and is considered conditionally significant adverse. This rating is based on the adverse effects on prey availability in the past from foreign, JV, and domestic groundfish fisheries, the state-managed salmon and herring fisheries, and indications that prey availability has been a key factor in the decline of the western population over the last several decades. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine with natural fluctuations to affect prey availability such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Spatial and Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** The spatial and temporal concentration of the fisheries under PA.1 does not substantially deviate from the baseline condition. Thus, the effects of the spatial/temporal concentration of the fisheries under PA.1 are determined to be insignificant to Steller sea lions.

- **Persistent Past Effects**. Past foreign, JV, and domestic groundfish fisheries, as well as state-managed fisheries for salmon and herring have all attempted to maximize their catch per unit effort by concentrating their fishing at times and places where fish are most concentrated. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries caused localized depletion of forage fish. Past changes in the domestic groundfish harvest regulations have dispersed the fishing effort in time and space in order to minimize the potential for localized depletion of Steller sea lion prey. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures, which constitute the baseline condition.

- **Reasonably Foreseeable Future External Effects**. The only reasonably foreseeable future factors external to the groundfish fisheries that may affect the survivability and/or reproductive success of the western Steller sea lion population include the state-managed salmon and herring fisheries, which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed in a manner similar to recent years. No new State of Alaska or federal fisheries are anticipated at this time.

- **Cumulative Effect**. The cumulative effect of the spatial/temporal harvest of prey is based on past and future effects of the groundfish fisheries and state-managed fisheries and is considered conditionally significant adverse. Although there are several hypotheses regarding the decline and lack of recovery of Steller sea lions, localized depletion of prey due to commercial fishing is a plausible mechanism for population level effects. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine to cause localized depletion of prey in key areas such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Disturbance

- **Direct/Indirect Effects**. Current federal groundfish fisheries disturbance to the western population of Steller sea lions is considered insignificant under the baseline condition. Since PA.1 retains the area closures contained under the baseline, disturbance levels under this PA.1 would also be considered insignificant at the population-level.

- **Persistent Past Effects**. Past sources of disturbance on the western population of Steller sea lions include foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Commercial harvests, intentional shootings, and subsistence harvests of Steller sea lions have also been identified as disturbance sources. General vessel traffic and disturbances to the prey field from gear have regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects**. Future disturbance is expected at some level from state-managed salmon and herring fisheries, as well as general fishing and non-fishing vessel traffic in Steller Sea lion foraging areas. Subsistence harvest is identified as a continuing source of disturbance to Steller sea lions. The level of disturbance is expected to be similar to the baseline conditions.

- **Cumulative Effects**. The level of disturbance to Steller sea lions resulting from internal and external effects is expected to be similar to baseline conditions, and is rated as insignificant under PA.1.

Direct/Indirect Effects PA.2 – Western Distinct Population Segment of Steller Sea Lions

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under PA.1 for the western population of Steller sea lions and are considered insignificant.

Fisheries Harvest of Prey Species

Under PA.2, the fishing mortality rate of EBS pollock is expected to increase by an average of 28 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key Steller sea lion prey species is considered to be significantly adverse (see the discussion under PA.1 regarding the aberrant fishing mortality rate in 2002, which served as the comparative baseline.) The harvest of EBS pollock under the PA.2 management regime meets the criteria of a significantly adverse impact to Steller sea lions, although the actual effect on Steller sea lions is likely not as significant in terms of the biomass of prey available, as discussed under PA.1.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 23 percent relative to the comparative baseline over the next five years under PA.2. This change in F is rated as significantly beneficial under the PA.2 scenario for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. There is no change in the projected catch of Aleutian Islands pollock between the baseline and PA.2; therefore, the effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level for this FMP.

Under PA.2, the BSAI and GOA Pacific cod fishing mortality rates are expected to decrease by 11 percent and increase six percent, respectively, over the next five years. These respective changes are determined to be insignificant to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are expected to be insignificant to Steller sea lions under the PA.2, with a projected increase in F of 15 percent relative to the baseline. Harvest of Aleutian Islands Atka mackerel under PA.2 would be insignificant to the western population of Steller sea lions.

Little difference is expected relative to the baseline and among the alternatives for harvest of other and non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions.

Under the comparative baseline conditions, the combined harvest of prey was found to not jeopardize the continued existence of the western populations of Steller sea lions (NMFS 2001a).While ratings for harvest of individual prey species range from significantly beneficial to significantly adverse, overall harvest levels under PA.2 would be somewhat reduced from the 2002 baseline conditions and are thus considered insignificant to the western population of Steller sea lions.

Spatial and Temporal Concentration of the Fishery

The criterion used to evaluate the spatial and temporal effects of the groundfish fisheries on marine mammal populations is that the FMP would be expected to result in either increased or decreased spatial and temporal concentrations in key marine mammal foraging areas, and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures, yet where Steller sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as global controls. Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the western population of Steller sea lions in the wild. The PA.2 alternative bookend offers opportunities for additional temporal and spatial protection by adjusting current protection measures as appropriate scientific information becomes available to avoid jeopardy to ESA-listed Steller sea lions. Future protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions and have the potential to provide beneficial effects to Steller sea lions. However, because additional spatial and temporal measures may or not be adopted and would depend on future research, no specific measures have been added or repealed under PA.2 so the spatial and temporal concentration of the fishery is not expected to significantly change relative to the baseline. PA.2 is therefore rated as insignificant for this effect.

Disturbance

Effects do not deviate from those described under PA.1 and are considered insignificant.

Cumulative Effects PA.2 – Western Distinct Population Segment of Steller Sea Lions

The past/present effects on the western population of Steller sea lions are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under PA.2 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects being change in prey availability and change in the spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, PA.2 is likely to have insignificant effects on the population trajectory of the western population of Steller sea lions.

- **Persistent Past Effects**. Past sources of mortality are the same as discussed under PA.1.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable future sources of mortality are the same as discussed under PA.1.

- **Cumulative Effects**. The level of mortality resulting from the internal groundfish fisheries and external sources is expected to exceed the PBR for this population. Thus, the cumulative effects under PA.2 are rated as significantly adverse. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and is not considered to cause jeopardy under the ESA (NMFS 2001a).

Prey Availability

- **Direct/Indirect Effects.** Under PA.2, the federal groundfish harvest of Steller sea lion prey species is expected to be similar to the baseline condition and is rated as insignificant.

- **Persistent Past Effects**. Past effects are the same as discussed under PA.1.

- **Reasonably Foreseeable Future External Effects**. The reasonably foreseeable future effects are the same as discussed under PA.1.

- **Cumulative Effects**. Cumulative effects on the fishing mortality rate of prey species resulting from internal and external removals is considered conditionally significant adverse. This rating is conditional on whether future combined harvests of Steller sea lion prey are a key factor in the continued decline or lack of recovery of the western population of Steller sea lions.

Spatial and Temporal Effects of Harvest

- **Direct/Indirect Effects.** Under PA.2, the effects of the spatial/temporal concentration of the groundfish fisheries are determined to be similar to those under baseline conditions and are thus rated as insignificant.

- **Persistent Past Effects**. Persistent past effects are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable future external effects are the same as described under PA.1.

- **Cumulative Effect**. The cumulative effect of the spatial/temporal harvest of prey is based on past and future effects of the groundfish fisheries and state-managed fisheries and is considered conditionally significant adverse. Although there are several hypotheses regarding the decline and lack of recovery of Steller sea lions, localized depletion of prey due to commercial fishing is a plausible mechanism for population level effects. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine to cause localized depletion of prey in key areas such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Disturbance

- **Direct/Indirect Effects**. The level of disturbance under PA.2 is expected to be similar to the baseline condition and is therefore considered insignificant.

- **Persistent Past Effects**. Past disturbance sources are the same as discussed under PA.1.

- **Reasonably Foreseeable Future External Effects**. The reasonably foreseeable future sources of disturbance are the same as discussed under PA.1.

- **Cumulative Effects**. The level of disturbance resulting from internal and external sources is expected to be similar to the baseline condition and is therefore considered insignificant.

4.9.8.2 Eastern Distinct Population Segment of Steller Sea Lions

Direct/Indirect Effects PA.1 – Eastern Distinct Population Segment of Steller Sea Lions

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, PA.1 is not likely to result in significant changes to the population trajectory of the eastern distinct population segment (eastern population) of Steller sea lions. No Steller sea lions from the eastern population were taken incidentally by groundfish fisheries from 1995-1999 (Angliss *et al.* 2001) (Table 4.5-60). In this context, incidental take refers to animals which are deceased or have injuries that are expected to result in death. Because no animals from the eastern population have been taken incidentally by groundfish fisheries, changes in catch resulting from PA.1 are not expected to result in an increase in the level of incidental takes.

Entanglement of Steller sea lions from the eastern population in derelict fishing gear or other materials seems to occur at frequencies that do not have significant effects on the population. Thus, incidental take and entanglement in marine debris under PA.1 is insignificant according to the significance criteria (Table 4.1-6).

Fisheries Harvest of Prey Species

BSAI groundfish fisheries are not likely to have large impacts on the prey availability of the eastern population of Steller sea lions, as there is little overlap with this population and fisheries which harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to affect the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock and Pacific cod under PA.1 are expected to decrease by 23 percent and increase by 19 percent, respectively, relative to the comparative baseline over the next five years. Changes in the fishing mortality rates expected to occur under PA.1 are significantly beneficial for GOA pollock and insignificant for Pacific cod harvests.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions.

The combined harvest of prey species for the eastern population of Steller sea lion under PA.1 is expected to be similar or less than the baseline conditions and have insignificant population-level effects on the eastern population of Steller sea lions.

Spatial and Temporal Concentration of the Fishery

The groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the eastern population of Steller sea lions. The spatial and temporal concentration of the fishery under PA.1 is not expected to change significantly relative to the baseline and is therefore rated as having insignificant effects on Steller sea lions.

Disturbance

PA.1 retains the area closures contained under the baseline. The management regime under PA.1 is not expected to result in increased disturbance to Steller sea lions relative to the baseline. The effects of disturbance are rated insignificant under the PA.1 management scenario.

Cumulative Effects PA.1 – Eastern Distinct Population Segment of Steller Sea Lions

The past/present effects on the eastern population of the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects being change in prey availability and change in spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. With regard to incidental take and entanglement, PA.1 is not likely to result in significant changes to the population trajectory of the eastern population of Steller sea lions.

- **Persistent Past Effects.** It is thought that shooting used to be a significant source of mortality prior to listing the Steller sea lion as threatened on the ESA. NOAA Fisheries, Alaska Enforcement Division has successfully prosecuted two cases of illegal shooting involving four Steller sea lions from the eastern population (Angliss *et al.* 2001). It is not known to what extent illegal shooting continues in the eastern population, but stranding of Steller sea lions with bullet holes still occurs. Predator control programs associated with mariculture facilities in British Columbia accounts for a mean of 44 animals killed per year from the eastern population (Angliss *et al.* 2001). The subsistence harvest in the eastern population of the Steller sea lion is very small and consists of an average of two Steller sea lions taken per year from southeast Alaska (1992-1997) (Angliss and Lodge 2002). Commercial harvest of Steller sea lions for hides and meat occurred prior to 1900 and likely depleted local populations. Over a nine year period (1963 to 1972) more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). The proportion of these from the eastern population are unknown. Steller sea lions are incidentally taken in low numbers by commercial fisheries other than groundfish fisheries, including some state-managed salmon drift and set gillnet fisheries and the salmon troll fishery in southeast Alaska (mean of 1.25 and 0.2, respectively) (Angliss *et al.* 2001). Small numbers of Steller sea lions from the eastern population are taken outside of southeast Alaska in groundfish fisheries (0.45 per year in Washington, Oregon, and California) and set gillnet fisheries in northern Washington State (0.2 per year) (Angliss *et al.* 2001). The PBR for this population is 1,396 and current human caused mortality is 45.5, substantially less than ten percent of the PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillnet and troll fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely be relatively low (less than ten per year). Groundfish fisheries in Washington, Oregon and California and salmon set gillnets fisheries will continue to take small numbers from this population. Entanglement and intentional shootings would be expected to continue. Pollution is likely more of a factor for this population due to its closer association with population centers. Climate changes and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effect.** The level of take resulting from internal effects of the groundfish fisheries and external mortality effects are expected to have a negligible impact on the eastern population of Steller sea lions. These combined effects are considered insignificant since the overall human-caused mortality does not approach the PBR for this population. Although this population is listed as threatened under the ESA, the population has been increasing over the last 20 years. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and is not determined to cause jeopardy under the ESA (NMFS 2001a).

Effects of Prey Availability

- **Direct/Indirect Effects.** The fishing mortality rate of Steller sea lion prey species under PA.1 is similar to baseline conditions and is not expected to result in population-level effects.

- **Persistent Past Effects**. Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State of Alaska waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. NOAA Fisheries issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat, although most of the focus was on the western population. The most recent Steller sea lion BiOp and EIS (NMFS 2001b and 2001c) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline conditions. New fisheries in State of Alaska or federal waters are not anticipated. Climate changes or regime shifts were identified as potentially having adverse effects of availability of prey, but the direction or magnitude of these changes are difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion, but effects of climate change or regime shifts on the eastern population of the Steller sea lion are largely unknown.

- **Cumulative Effects**. The cumulative effects of prey availability on the eastern population of the Steller sea lion are considered to be insignificant at the population level. The eastern population of Steller sea lions has been increasing steadily over the last 20 years so prey availability is not considered to be limiting the recovery of the population.

Spatial and Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The spatial and temporal concentration of the fisheries under PA.1 is not expected to deviate from the baseline and is therefore determined to be insignificant to the eastern population of Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial and temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures, which remain in effect under PA.1.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon set and drift gillnet fisheries, salmon troll fisheries and herring fisheries are expected to continue in future years in a manner similar to the baseline conditions.

- **Cumulative Effects**. The cumulative effect of the spatial and temporal harvest of prey based on both internal effects of the groundfish fishery and external effects, such as the state-managed fisheries, is likely to remain similar to the baseline condition, which has occurred while the population has increased steadily, and is therefore considered insignificant for the eastern population of Steller sea lions.

Disturbance

- **Direct/Indirect Effects**. The disturbance levels on Steller sea lions under the PA.1 are expected to be similar to the baseline condition and are not expected to have a population-level effect. Therefore, PA.1 is considered insignificant. Protection measure around rookeries and haul-outs will continue under PA.1.

- **Persistent Past Effects.** Past disturbance was identified from foreign, JV, and federal domestic groundfish fisheries, and state-managed salmon and herring fisheries. General vessel traffic has also contributed to the disturbance level on this population. Intentional shooting has likely been a disturbance factor in past years.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries and vessel traffic will likely continue in the future at a level similar to the baseline conditions. Disturbance from subsistence harvest is not a issue for this population.

- **Cumulative Effects**. The cumulative effects on disturbance levels resulting from internal and external sources are expected to be similar to baseline conditions and are not likely to have a population-level effect. Therefore, disturbance under PA.1 is considered insignificant.

Direct/Indirect Effects PA.2 – Eastern Distinct Population Segment of Steller Sea Lions

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Fisheries Harvest of Prey Species

BSAI groundfish fisheries are not likely to have large impacts on the prey availability of the eastern population of Steller sea lions, as there is little overlap with this population and fisheries which harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to affect the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock under PA.2 are expected to decrease 29 percent relative to the comparative baseline over the next five years. Average fishing mortality rates of GOA Pacific cod are expected to increase by six percent relative to the comparative baseline over the next five years. The changes in the fishing mortality rate expected to occur under PA.2 are significantly beneficial for GOA pollock and insignificant for Pacific cod harvests.

Little difference is expected relative to the baseline and among the alternatives for harvest of other and non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the FMP alternatives were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under PA.2 is expected to result in insignificant population-level effects on the eastern population of the Steller sea lions.

Spatial and Temporal Concentration of the Fishery

The spatial and temporal measures in PA.2 were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions. The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures, yet where sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as global controls. Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the eastern population of Steller sea lions in the wild. PA.2 offers opportunities for additional temporal and spatial protections which would offer increased protection in areas determined to be important for Steller sea lions. These protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions and have the potential to provide beneficial effects to Steller sea lions. However, because additional spatial and temporal measures may or not be adopted and would depend on future research, no specific measures have been added or repealed under PA.2 so the spatial and temporal concentration of the fishery is not expected to significantly change relative to the baseline. PA.2 is therefore rated as insignificant for this effect.

Disturbance

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Cumulative Effects PA.2 – Eastern Distinct Population Segment of Steller Sea Lions

For the eastern population of the Steller sea lions, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

4.9.8.3 Northern Fur Seals

Direct/Indirect Effects PA.1 – Northern Fur Seals

Incidental Take/Entanglement in Marine Debris

The incidental take of northern fur seals is uncommon in the groundfish fisheries. The last recorded mortality in any Alaskan groundfish fishery occurred in 1996, when the take rate was one animal per 1,862,573 mt of groundfish harvested. Observer records from 1990 to 1999 indicate that direct interactions with groundfish vessels occurred only in the BSAI trawl fishery, despite observer placement in pot, longline and trawl fisheries in both the BSAI and GOA. In the BSAI trawl fishery, the average annual take rate (1995 to 1999) was 0.6. This level of take is inconsequential to population trends.

Northern fur seal entanglement in marine debris is more common than any other species of marine mammal in Alaskan waters (Laist 1987, 1997, Fowler 1987). Fowler (1987) concluded that mortality of northern fur seals from entanglement in marine debris contributed significantly to declining trends in the Pribilof Islands during mid to late 1970s and early 1980s. The contribution of intentional discard of net debris from Alaskan groundfish fisheries vessels is thought to have declined over the past decade. However, consistent numbers of seals entangled in packing bands on St. Paul Island may reflect disposal of these materials in proximity to the islands. Recent data from satellite-tracked drifters deployed in the Bering Sea suggests a "trapped" circulation pattern around the Pribilof Islands (Stabeno *et al.* 1999) which may retain marine debris in the nearshore environment. An increase in the number of Antarctic fur seals (*Arctocephalus gazella*) entangled in polypropylene packing bands was observed at Bird Island, South Georgia, in the late 1980s as these materials came into common usage by at-sea processing vessels (Croxall *et al.* 1990). Involuntary sources of marine debris, as in loss of gear, are diminishing as fishery cooperative systems develop (such as in the BSAI offshore pollock allocation). That is, as the pace of fisheries is slowed, there is less incentive to risk capital equipment. Data do not yet exist to assess the rates at which various gear types are lost or discarded to result in risk to fur seals, especially in regard to fishery or nation of origin. In consideration of progress in stemming the loss and discard of net fragments and other plastic debris by domestic commercial fisheries, the extent to which the current FMP could change the rate of fur seal entanglement in marine debris is considered to be low. There seem to be few options, given the likelihood that sources beyond the control of fisheries managers (i.e., foreign fisheries, international shipping, and shoreside refuse) constitute significant sources of discard. According to these factors and projected catch levels under PA.1, incidental takes and entanglements of northern fur seals are expected to occur incidental to groundfish fisheries at levels that are not expected to result in population-level effects. Increased harvest rates under this management alternative are not large enough for expected take levels to increase relative to the baseline. Therefore, this effect is rated insignificant under PA.1 as it is under baseline conditions.

Fisheries Harvest of Prey Species

The diet of northen fur seals includes a wide range of fish species, with less apparent dependence on Pacific cod and Atka mackerel compared to Steller sea lions. However, both adult and juvenile pollock occur in the diet of northern fur seals and consumption rates vary according to the abundance of different age classes of pollock in the foraging environment (Swartzman and Haar 1983, Sinclair *et al*. 1996). Because fur seals are opportunistic foragers, the presence of strong year-classes results in a disproportionately high percentage of that age class of pollock in the fur seal diet. Evaluation of the effects of harvest of prey species on northen fur seals, focuses less on removals of Pacific cod and Atka mackerel and more broadly on removals of pollock and small schooling fishes. Northen fur seals forage at shallow to mid-water depths of 0 to 820 ft (0-250 m), both near shore and in pelagic regions of their migratory range. Female and young male fur seals generally consume both juvenile and adult small-sized (2 to 8 inches) schooling fishes and squids although diet varies across oceanographic subregions along heir migration routes and around breeding location in the Pribilof Islands. In the eastern Bering Sea, primary prey species include pollock and pacific cod, but deep sea smelts, lanternfish, and squids are also major components. Studies based on scat analyses have indicated that the pollock and Pacific cod consumed by fur seals tend to be smaller than those selected by the target fisheries; however, data from stomach collections from the 1960s through the 1980s indicate that fur seals often consume adult pollock. Recent studies using bio-chemical methods to study the diet of northen fur seals suggest that the diet of deep diving fur seals in water over the continental shelf includes adult pollock (Kurle and Worthy 2000, Goebel 2002).

Under PA.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 23 percent relative to the comparative baseline. Assuming that adult pollock are a key prey species of the northern fur seal, this change in the harvest is rated significantly adverse according to the significance criteria for effects on marine mammals. However, the actual effect of this increased harvest rate, in terms of biomass available, is likely insignificant due to the abnormally low fishing mortality under the comparative baseline (see the discussion regarding the aberrant fishing mortality rate of EBS pollock in 2002 in Section 4.9.8.1.)

Catches of squid and small schooling fish (e.g., fish designated in the forage fish assemblage) in the groundfish fisheries of the BSAI and GOA are low, generally less than 1,000 mt per year. While precise biomass estimates for these groups do not exist, the exploitation rate on these groups in the groundfish fisheries is thought to be very low. For instance, squid biomass in the Bering Sea may be as large as 4 million mt, based on marine mammal food habits, daily ration, and abundance data (Sobolevsky 1996). Similarly, with respect to small schooling fishes, consumption of capelin in the GOA by arrowtooth flounder alone may be as large as 300,000 mt per year (Livingston 1994). Assuming that these crude projections of squid and capelin biomass at least approximate the order of magnitude of the true population levels, then the fisheries removals would amount to only a fraction of one percent of those populations. Fisheries for pollock and Pacific cod do not target fish younger than 3 years of age (Ianelli *et al.* 1999, Dorn *et al.* 1999, Thompson and Dorn 1999, Thompson and Zenger 1994, Fritz 1996). Catches of pollock smaller than 30 centimeters (cm) are small, and thought to be only 1 to 4 percent of the number of one- and two-year olds each year in the EBS and GOA (Fritz 1996).

While fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), the harvest rates of those species in the size range consumed by fur seals tend to be low. Furthermore, the fraction of the northern fur seal diet composed of those species is a smaller fraction of the overall diet as compared, for instance, to Steller sea lions. The overall harvest of northern fur seal prey species is likely to be similar to the baseline condition and is therefore determined to be insignificant under PA.1.

Spatial and Temporal Concentration of the Fishery

Spatial and temporal fishing measures in PA.1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under the PA.1 are determined to be insignificant to northern fur seals according to the criteria established in Table 4.1-6. However, effects to northern fur seals from spatial/temporal concentration of the fisheries under the strategy defined as the baseline for this environmental analysis were rated conditionally significant adverse in the Steller sea lion SEIS (NMFS 2001b). Therefore, while the spatial/temporal effects of PA.1 are insignificant relative to the baseline, the baseline has been described as having potential adverse effects on northern fur seals.

In recent years, fishing effort for pollock has increased in nearshore areas around the Pribilof Islands (NMFS 2003) where northern fur seals are known to forage. The greatest potential for temporal overlap between northern fur seals and the pollock fishery in the eastern Bering sea is July through November. Under the baseline, pollock fisheries were extended in order to slow the pace of the fishery and may now occur from June through October. This disperses the harvest over a longer time period than in previous seasons, thereby reducing temporal concentration of the fisheries. However, this change also extends the fisheries into the summer months when fur seals are concentrated near the Pribilof Island rookeries and may thus increase the likelihood of localized effects in foraging areas near the Pribilofs (NMFS 2001b). Seasonally, the highest bycatch of small pollock occurs during the summer (May-July) when spawning aggregations have dispersed and pollock are generally less segregated by size (Fritz 1996). Given the expected temporal dispersal of the fisheries under PA.1 and the steadily increasing biomass trends for pollock, the magnitude of harvest and bycatch of species/size classes important to fur seals during the breeding season is not expected to cause localized depletion of prey to the point that the fur seal population as a whole will be affected. Therefore, the spatial/temporal concentration of the fishery under PA.1 is determined to be insignificant to northern fur seals.

Disturbance

Disturbance from the baseline level of fishing activities has not been implicated as a potential cause for the population decline of northern fur seals. PA.1 is expected to produce similar levels of disturbance as the baseline which are unlikely to have population-level effects and are therefore considered insignificant according to the significance criteria established in Table 4.1-6.

Cumulative Effects PA.1 – Northern Fur Seals

A summary of the effects of the past/present with regards to the northern fur seal are presented in Section 3.8.2. (Table 3.8-2). The predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey an spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. Under PA.1, incidental take and entanglement is not expected to have a population-level effect and is rated as insignificant.

- **Persistent Past Effects**. Past effects of mortality on fur seal population include commercial harvest of young males up to 1985, harvest of females between 1956 and 1968, incidental take in the JV fisheries, foreign fisheries, and annual subsistence harvest on the Pribilof Islands. Commercial harvest of fur seals peaked in 1961 with over 126,000 animals, but was halted in 1985. The harvest of female fur seal on the Pribilof Islands, as many as 300,000 between 1956 and 1968, likely contributed to the decline of the population in the late 1970s and early 1980s (York and Kozloff 1987). This precipitous decline resulted in its depleted status under the MMPA. Entanglements may have contributed significantly to declining trends of the population during the late 1970's (Fowler 1987). Since the cessation of commercial harvest in 1985, fur seal number have steadily declined (NMFS 1993, Angliss and Lodge 2002). The contribution of the earlier harvest of fur seal to the subsequent decline is uncertain, since it has been nearly 20 years since commercial harvest was ended. Subsistence harvests have been one of the major contributors to fur seal mortality in recent years. From 1986 to 1996, the average annual subsistence take was 1,605 from St. Paul and St. George Islands. From 1995 to 2000 this average take dropped to 1,340 seals per year, which represents about 8 percent of the PBR for this species.

- **Reasonably Foreseeable Future External Effects**. These effects include incidental take from foreign fisheries outside the U.S. EEZ where fur seal are widely dispersed. State-managed fisheries take small numbers of fur seals, including the PWS drift gillnet fisheries, Alaska Peninsula and Aleutian Islands salmon gillnet fisheries, and the Bristol Bay salmon fisheries (Angliss *et al.* 2001). Subsistence will continue to be a major source of mortality in the future, but is limited to the Pribilof Islands. Levels of take are expected to be well below ten percent of the PBR for this species. Short-term and long-term climate changes are not considered a direct mortality factor for this species.

- **Cumulative Effects**. The cumulative effects of mortality resulting from internal and external effects are considered insignificant due to the large size of the fur seal population and the low levels of take, which are well below the PBR for this species. The contribution of the groundfish fisheries is very small and approaches zero.

Availability of Prey

- **Direct/Indirect Effects.** The effects of the groundfish fisheries under PA.1 include the removal of northern fur seal forage; however, the size of the fish removed is an important factor in determining whether competitive overlap with fisheries would occur. Overall, the harvest of northern fur seal prey species is rated as insignificant since the harvest rates of those species in the size range consumed by fur seals tend to be low.

- **Persistent Past Effects.** Effects of groundfish harvest in the past has likely occurred from overlap of prey species and fish targeted by the foreign and JV fisheries in the BSAI as well as the State of Alaska and federal fisheries. Climatic and oceanic fluctuations are suspected in past changes in the abundance and distribution of prey.

- **Reasonably Foreseeable Future External Effects**. Effects of fisheries on prey species harvest in the future are expected to include a small overlap in prey species with the state-managed fisheries in nearshore areas. Climate changes and regime shifts could influence prey species abundance and distribution. Climate effects are largely unknown, but could potentially have adverse effects on the availability of prey.

- **Cumulative Effects**. The cumulative effect of prey availability from both the internal contribution of the groundfish fisheries and external effects on prey such as other fisheries and possibly long-term climate change is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Spatial/Temporal Concentration of Harvest

- **Direct/Indirect Effects**. The effects of the spatial and temporal concentration of the fisheries under PA.1 are determined to be insignificant to northern fur seals as they do not deviate from the spatial and temporal measures under the baseline conditions.

- **Persistent Past Effects**. Effects of past fisheries on prey availability are primarily from the foreign and JV fisheries and the state and federal domestic fisheries in the BSAI. There has been concern with regard to displaced/increased fishing effort that is encroaching into nearshore areas of the Pribilof Islands resulting in increased overlap with fur seal foraging habitat. The proportion of the total June-October pollock catch in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is a particular concern for the potential impact of this increased fishing pressure on lactating females from St. George Island where catch rates were consistently higher than in areas used by females from St. Paul (Robson *et al.* 2004).

- **Reasonably Foreseeable Future External Effects**. Effects of the spatial and temporal harvest of prey species is primarily from the foreign and federal domestic fisheries outside the EEZ due to the extensive range of the fur seal. State-managed fisheries have very limited overlap with fur seal prey. Climate change was identified as a potential factor in spatial and temporal effects on prey.

- **Cumulative Effects**. The cumulative effect of the spatial/temporal harvest of prey based on the presence of internal and external factors is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established, and there is uncertainty regarding whether future fisheries harvests will contribute to the decreasing population trend, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance are not expected to depart substantially from those which occurred to northern fur seals under the baseline conditions. Therefore, the effects of disturbance on northern fur seals are expected to be insignificant under PA.1.

- **Persistent Past Effects**. Persistent past effects on fur seal disturbance include commercial groundfish fisheries harvest by JV fisheries, foreign and federal domestic fisheries, and to a lesser extent, the subsistence harvest of fur seals on the Pribilof Islands. It is unknown whether these past activities have persisted to the present, but the ongoing fisheries continue to result in some level of disturbance to fur seals while they are in the BSAI region. Recent spatial and temporal measures associated with Steller sea lion protective measures have increased the overlap of fishing activity and northern fur seal foraging habitat (NMFS 2001b).

- **Reasonably Foreseeable Future External Effects**. Future disturbance effects on fur seals were identified as state-managed fisheries, general vessel traffic, and subsistence activities on the Pribilof Islands.

- **Cumulative Effects**. The cumulative effects of disturbance from internal and external factors are considered insignificant because there is little to indicate adverse effects occurring on the population level.

Direct/Indirect Effects PA.2 – Northern Fur Seal

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under PA.1 bookend and are considered insignificant.

Fisheries Harvest of Prey Species

Under PA.2, the fishing mortality rate of EBS pollock is expected to increase by an average of 34 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest is rated significant assuming that adult pollock are a key northern fur seal prey species (see the discussion regarding the aberrant fishing mortality rate of EBS pollock in 2002 in Section 4.9.8.1).

While fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), the harvest rates of those species in the size range consumed by fur seals tend to be low. Furthermore, the fraction of the northern fur seal diet composed of those species is a smaller fraction of the overall diet as compared, for instance, to Steller sea lions. The overall harvest of northern fur seal prey species was rated insignificant under PA.2.

Spatial and Temporal Concentration of the Fishery

PA.2 includes provisions for future scientific research intended to help refine spatial/temporal protection measures that further reduce impacts of the fisheries on Steller sea lions. While past sea lion protection measures may have increased fishery impacts on northern fur seals by redirecting the fisheries into places and times that overlap with fur seal foraging habitat, PA.2 also includes a management objective to minimize impacts on non-ESA-listed species of marine mammals. Development of new spatial/temporal protection measures would therefore need to be a balance between protecting the interests of different species, including fur seals. Because additional spatial/temporal measures may or not be adopted and would depend on future research, no specific measures have been added or repealed under PA.2. For this analysis, it will be assumed that the spatial and temporal concentration of the fishery will be similar to the baseline or will be modified in such a way as to be relatively beneficial to prey fields of marine mammals in general. The spatial/temporal concentration of the fishery under PA.2 is therefore rated as having insignificant effects on northern fur seal.

Disturbance

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Cumulative Effects PA.2 – Northern Fur Seal

For northern fur seals, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

4.9.8.4 Harbor Seals

Direct/Indirect Effects PA.1 – Harbor Seals

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, incidental takes and entanglements of harbor seals incidental to groundfish fisheries under PA.1 are not expected to result in population-level effects. Increased harvest rates under this management FMP may result in the increased take of one harbor seal relative to the baseline, for a total estimated average of less than five animals per year. This level of incidental take would not result in changes to the population trajectory for this species. Therefore, takes and entanglements of harbor seals incidental to groundfish fisheries are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The major prey of harbor seals in Alaskan waters include fish from the following families: Gadidae, Clupeidae, Cottidae, Pleuronectidae, Salmonidae, Osmeridae, Hexagrammidae, and Trichodontidae. Octopus and gonatid squid are also important. However, overlaps with commercial groundfish fisheries occur primarily with reference to pollock, Atka mackerel, and Pacific cod, which may constitute grounds for indirect interactions, particularly in the GOA and Aleutian Islands. However, the basis for concern is less pronounced than those noted for Steller sea lions, or even for northern fur seals, so that the overall effects are likely to be lower as well. Pollock, Atka mackerel, and Pacific cod constitute approximately 12, 9, and 8 percent, respectively, of harbor seal diet in the Aleutian Islands and Bering Sea (Perez 1990). In the GOA, pollock, octopus and capelin were reported by Pitcher and Calkins (1979) as the most important prey, while Pacific cod was less important and Atka mackerel were absent in the sample. Ashwell-Erickson and Elsner (1981) estimated that harbor seals and spotted seals combined consume approximately 81,600 mt of pollock per year, compared to current Bering Sea pollock biomass estimates (1998) of over 9 million mt. Pollock removals by fisheries are less than 10 percent of the biomass estimate, suggesting that in terms of volume, the unharvested fraction, under baseline conditions, is sufficient to satisfy harbor seal foraging needs.

Under PA.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 23 percent relative to the comparative baseline. According to the significance criteria for the effects on marine mammals, the change in the harvest of this key harbor seal prey species is rated significant (see the discussion regarding the comparative baseline fishing mortality rate in Section 4.9.8.1.) The harvest of EBS pollock under the PA.1 management regime meets the criteria of a significantly adverse impact to harbor seals, but the actual effect in terms of biomass available is likely insignificant due to the unusually low fishing mortality under the baseline.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 23 percent under the PA.1 bookend relative to the comparative baseline over the next five years and rated insignificant at the population level for harbor seals. Under the PA.1, the BSAI Pacific cod fishing mortality rate is expected to decrease by 19 percent, which is determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under the PA.1 bookend is expected to be significantly adverse to harbor seals with a 61 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other and non-target species that are prey for harbor seals (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to harbor seals.

Although there is overlap in species/size classes taken by the groundfish fisheries and harbor seal prey, harbor seals also consume a large amount of other prey species. Overall, the combined harvest of harbor seal prey species under PA.1 is not expected to increase substantially from the baseline condition or to result in population-level effects and is therefore considered insignificant.

Spatial and Temporal Concentration of the Fishery

The effects of the spatial and temporal concentration of the fisheries under PA.1 are determined to be insignificant to harbor seals as they do not deviate from the spatial and temporal measures under the baseline conditions.

Disturbance

The potential for disturbance effects caused by vessel traffic, fishing gear, or noise appears limited for harbor seals. These animals are common in inshore waters subjected to considerable levels of anthropogenic disturbances, typical of ports and shipping lanes. Interactions with groundfish fishing gear, such as trawl nets, also appears limited, based on the rare incidence of takes in the groundfish fisheries. Finally, given the near shore distribution of harbor seals, their overlap with fishing activities is more limited than in the case of either Steller sea lions or northern fur seals. Disturbance of harbor seals under PA.1 is not expected to increase relative to the baseline and is rated insignificant.

Cumulative Effects PA.1 – Harbor Seals

A summary of the effects of the past/present with regards to the harbor seal are presented in Section 3.8.4 (Table 3.8-4). The predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. Incidental take and entanglements of harbor seals expected to occur incidentally in the groundfish fisheries under PA.1 are not expected to result in a population-level effect and are considered insignificant.

- **Persistent Past Effect**. Residual effects on local populations from State of Alaska predator control programs (1950s to 1972) and commercial hunts (1963 to 1972) may still exist in some areas, although there are no data on these factors. Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear, but based on the near shore distribution of harbor seals, there was likely minimal direct interaction and mortality. From 1990 to 1996, minimum estimates of harbor seals taken incidentally in groundfish gear in the Bering Sea were four per year and less than one per year in the GOA. In southeast Alaska, four harbors seals are estimated to be killed each year on longlines. Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species, since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide subsistence harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which are taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). Harvest of the Bering Sea stock of harbor seals is approximately 161 animals, 42 percent of PBR for this species. For the GOA stock, the subsistence harvest is at approximately 91 percent of the PBR for this stock. For the southeast stock, subsistence harvest is at approximately 83 percent of PBR.

- **Reasonably Foreseeable Future External Effects**. Incidental take of harbor seal in state-managed fisheries such as salmon set and drift gillnet fisheries would be expected to continue at the present low rate. Subsistence take is expected to continue to be the greatest source of human controlled mortality with a relatively high percentage of the PBR in both the GOA and southeast Alaska stock, with a lower take in the BSAI region. Climate changes are not likely factors in the direct mortality of harbor seal, although there would likely be indirect effects.

- **Cumulative Effects**. The combined effects of mortality resulting from internal effects and external sources are determined to be insignificant. The human-caused mortality for all harbor seals is below the PBR for each stock and, therefore, population-level effects are unlikely.

Availability of Prey

- **Direct/Indirect Effects**. The combined harvest of harbor seal prey species under PA.1 is not expected to result in a population-level effect and is considered insignificant.

- **Persistent Past Effects**. Availability of prey for harbor seal in the past has likely been adversely affected by foreign, JV, and federal domestic groundfish fisheries and state-managed salmon and herring fisheries since the fish targeted by these fisheries are prey of the harbor seal. Climates changes regime shifts could have possibly been factors in fluctuations of prey availability in the past.

- **Reasonably Foreseeable Future External Effects**. State-managed salmon and herring fisheries are identified as potential adverse effects on harbor seal prey availability. Climate change regime shifts will continue to be contributing factors, although the effects can be either beneficial or adverse, depending on the direction and magnitude of the change.

- **Cumulative Effects**. The combination of internal effects of the groundfish fisheries and other external fisheries on prey availability were determined to be conditionally significant adverse. This rating is based on the fact that the population has declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional.

Spatial and Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The effects of PA.1 on the reproductive success and survivability of harbor seals resulting from the spatial and temporal concentration of the fisheries are rated as insignificant.

- **Persistent Past Effects.** Effects on harvest concentration in the past has likely occurred due to overlap of harbor seal prey species and fish targeted in areas fished by the foreign and JV fisheries in the BSAI, as well as the State of Alaska and federal fisheries. Climatic and oceanic fluctuations are not considered to be factors in past changes.

- **Reasonably Foreseeable Future External Effects**. Future changes in the spatial/temporal harvest could cause competitive overlap in prey species with the state-managed fisheries in nearshore areas, such as salmon and herring. Since these fisheries generally occur in the nearshore areas in comparison to other groundfish fisheries, overlap is more pronounced than with the groundfish fisheries. Effects of climate changes regime shifts on prey species may affect prey abundance and distribution.

- **Cumulative Effects**. The cumulative effect of the spatial/temporal harvest of prey from internal effects of the groundfish fisheries and external effects of other fisheries is considered to be conditionally significant adverse, based primarily on past effects and contributions from state-managed fisheries. This rating is based on the fact that the population has declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established, the potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional.

Disturbance

- **Direct/Indirect Effects.** Disturbance levels under PA.1 are expected to be remain similar to the baseline condition and are rated as insignificant.

- **Persistent Past Effects**. Past disturbances on harbor seals include foreign, JV, and federal domestic groundfish fisheries, and to a lesser extent, the subsistence harvest of harbor seal. It is unknown whether these past effects have persisted into the present population, but the ongoing fisheries activities and subsistence continue to result in some level of disturbance to harbor seal.

- **Reasonablely Foreseeable Future External Effects**. State-managed fisheries, general vessel traffic and subsistence activities would be expected to continue to create some level of disturbance to harbor seal in the foreseeable future.

- **Cumulative Effects**. Cumulative effects were identified for disturbances resulting from internal sources and external factors such as other fisheries. Effects are expected to be similar to the baseline conditions and are considered insignificant.

Direct/Indirect Effects PA.2 – Harbor Seals

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Fisheries Harvest of Prey Species

Under PA.2, the fishing mortality rate of EBS pollock is expected to increase by an average of 23 percent relative to the comparative baseline. According to the significance criteria for the effects on marine mammals, the change in the harvest of this key harbor seal prey species is considered to be significant. The harvest of EBS pollock under the PA.2 management regime meets the criteria of a significantly adverse impact to harbor seals, but the actual effect is likely insignificant due the unusually low fishing mortality under the baseline.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 29 percent under the PA.2 bookend relative to the comparative baseline over the next five years, which is determined to be significantly beneficial to harbor seals. Under PA.2, the BSAI Pacific cod fishing mortality rate is expected to increase by 11 percent, which is determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under the PA.2 bookend is expected to be insignificant to harbor seals with a 15 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other and non-target species that are prey for harbor seals (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various alternatives were determined to be insignificant to harbor seals. Overall, the combined harvest of harbor seal prey species under PA.2 is expected to be similar to the baseline and to result in insignificant population-level effects.

Spatial and Temporal Concentration of the Fishery

The PA.2 bookend offers opportunities for additional temporal and spatial protections relative to the baseline condition and may be more precautionary in regards to prey availablity. Under PA.2, additional protection for Steller sea lions, such as fishing closures and areas closed under MPAs or no-take preserves, would potentially offer increased protection to harbor seal foraging areas. These protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions, and have the potential to provide beneficial effects to harbor seals based on the assumption that they may result in improvements to the prey field. For this analysis, it will be assumed that the spatial and temporal concentration of the fishery will be similar to the baseline or will be modified in such a way as to be relatively beneficial to marine mammals in general. PA.2 is therefore rated as insignificant for this effect.

Disturbance

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Cumulative Effects PA.2 – Harbor Seals

For harbor seals, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

4.9.8.5 Other Pinnipeds

Direct/Indirect Effects PA.1 – Other Pinnipeds

Incidental Take/Entanglement in Marine Debris

The incidental take rates in commercial fisheries for ice seals, walrus and northern elephant seals are very low. Mean annual mortality of all ice seals combined from 1995 - 1999 was estimated to be 1.8 animals based on NMFS observers on board BSAI groundfish trawl, longline, and pot fishing vessels (Angliss *et al.* 2001) (Table 4.5-60). These rates constitute levels approaching zero according to NMFS standards (Angliss *et al.* 2001) and are not expected to affect the population trajectories of the species included in this category. The take rate walrus and elephant seal qualifies as an insignificant level, approaching zero by NMFS standards (Forney *et al.* 2000) and is not expected to affect population trajectory of these species. Entanglement in marine debris is likewise rare for these species and is considered to have insignificant effects. Of the Federally-managed fisheries in Alaska, only the EBS and Aleutian Islands pollock fishery would be likely to have an impact on ice seals and walrus, because of their northern distribution in the Bering Sea. Because of their distribution in Alaska in the GOA and south of the Aleutian Islands (Stewart and DeLong 1994, LeBoeuf *et al.* 2000), northern elephant seals would be likely to be affected only by the GOA and Aleutian Islands pollock and cod fisheries. Due to the low level of documented interactions between other pinnipeds and the groundfish fisheries, incidental takes and entanglements of other pinnipeds occurring in the groundfish fisheries under PA.1 are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

With the exception of spotted seals, the food habits of the ice seals do not overlap with commercial fisheries targets. Bearded seals consume primarily benthic prey including crabs and clams as well as shrimps and Arctic cod (Kosygin 1966, 1971, Lowry *et al.* 1981a, 1981b). Ringed seals eat Arctic cod, saffron cod, smelt, herring, shrimps, amphipods and euphausiids (Fedoseev 1984, Johnson *et al.* 1966, Lowry *et al.* 1980, McLaren 1958). Ribbon seal diet has been characterized as intermediate between ringed and bearded seals (Shustov 1965). Spotted seals include pollock in their diet when feeding in the central Bering Sea (Bukhtiyarov *et al.* 1984), but their use of that resource in the EBS and Aleutian Islands is unknown. Spotted seal diet in Bristol Bay, the Priblof Islands and the eastern Aleutian Islands is likewise unknown, but if similar to harbor seals in those areas, it is likely to be diverse and may include a small percentage of commercially important species. Fishery harvests of ice seal prey species are expected to be minimal under PA.1 and are therefore determined to be insignificant.

The Pacific walrus diet is composed almost exclusively of benthic invertebrates (97 percent), particularly bivalve molluscs. Fish ingestion has been considered incidental to their normal feeding behavior (Fay and Stoker 1982). Therefore, groundfish removals would have an insignificant effect on walrus prey abundance.

The diet of northern elephant seals in the GOA is unknown; however, this species is known to be a deep diver. This behavior suggests that their foraging may be partitioned by depth from most groundfish fishing activities. The effects of groundfish harvests under PA.1 on prey species for northern elephant seals is determined to be unknown.

Spatial and Temporal Concentration of the Fishery

Due to the limited potential for competitive overlap to occur between other pinnipeds and the groundfish fisheries, the spatial and temporal concentrations of the fisheries are expected to have insignificant effects on species in this category under PA.1.

Disturbance

Disturbance of other pinnipeds under the PA.1 management regime is not expected to change relative to the baseline, which is considered of negligible effect, and is rated as insignificant.

Cumulative Effects PA.1 – Other Pinnipeds

A summary of the effects of the past/present with regards to other pinnipeds are presented in Section 3.8.3 and Section 3.8.5 through Section 3.8.9 (Tables 3.8-3, 3.8-5 through 3.8-9). The predicted direct/indirect effects and cumulative effects under PA.1 are described in Table 4.9-5.

Mortality

- **Direct/Indirect Effects**. Population-level effects are not expected to result from incidental take and entanglement for any of the species in this group under the PA.1. Therefore, PA.1 is rated as insignificant for the mortality of other pinnipeds.

- **Persistent Past Effects**. Past external effects on the populations of other pinnipeds includes low levels of incidental take in the foreign, JV, and domestic groundfish fisheries and low levels of take in the state-managed fisheries (see Sections 3.8.3, and 3.8.5 through 3.8.9). Subsistence is the major human-caused external factor for mortality. Subsistence annual harvest rates include 5,265 spotted seal, 6,788 bearded seal, 100 ribbon seal, 9,567 ringed seal, 1,000 walrus, and zero elephant seal.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries will likely continue to take very small numbers of seals in this group. Subsistence take of these marine mammals will likely continue at a similar rate to the baseline conditions.

- **Cumulative Effect**. The combined effects of mortality within the other pinniped group resulting from internal effects of the groundfish fisheries and external effects, such as subsistence harvest, are considered insignificant. For spotted, ringed, bearded, and ribbon seals, PBRs cannot be calculated. Walrus take is below PBR and population level effects are unlikely. Elephant seal populations are expanding so overall mortality is considered insignificant. Contributions of the groundfish fisheries to overall mortality is very small.

Abundance of Prey

- **Direct/Indirect Effects.** Except for elephant seals, where the amount of prey overlap is unknown, there is very little overlap of species taken in the groundfish fisheries with prey of the pinnipeds in this group and the effects of fisheries harvest on prey species are determined to be insignificant under PA.1.

- **Persistent Past Effects**. Past effect on spotted seal include foreign, JV, and domestic groundfish fisheries and state-managed fisheries for salmon and herring. For the other ice seals, elephant seals and walrus, no persistent past effects were identified due to the lack of overlap with the groundfish fisheries.

- **Reasonably Foreseeable Future External Effects**. Future effects were identified for state-managed fisheries for the spotted seal. Climate changes may be either beneficial or adverse factors for ice seals due to the potential climatic effects on the extent of ice cover in the Bering Sea and associated indirect effects on the abundance and distribution of prey.

- **Cumulative Effects**. The cumulative effect of all fisheries on the abundance of prey for pinnipeds is considered insignificant for all species. Spotted seals have some overlap of prey with the groundfish fisheries but the harvest of prey by the fisheries is not expected to have population level effects. The amount of groundfish fishery overlap with elephant seals is unknown but, since the elephant seal population is expanding, food does not appear to be limiting so cumulative effects on prey availability are considered insignificant. The amount of prey overlap with the other pinniped species is very limited and is considered insignificant for all species in this group.

Spatial and Temporal Concentration of Fisheries

- **Direct/Indirect Effects**. Spatial and temporal fishing measures under PA.1 do not deviate from the baseline, which has insignificant effects on pinniped species.

- **Persistent Past Effects**. Persistent past effect on spotted seal include foreign, JV, and domestic groundfish fisheries and state-fisheries. None are identified for the other pinniped species.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries within the range of spotted seal would be expected to be conducted in the future in a manner similar to the baseline conditions. Future effects of spatial and temporal concentration of fisheries on ice seals and walrus would not be expected.

- **Cumulative Effects.** The spatial/temporal concentration of the groundfish fishery and all other fisheries is considered to have an insignificant cumulative effect on pinniped prey due to limited seasonal overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects**. Levels of disturbance similar to the baseline are expected under PA.1 and are considered insignificant.

- **Persistent Past Effects.** Past sources of disturbance on spotted seals have been from the foreign, JV, and the federal domestic groundfish fisheries in the BSAI and state-managed fisheries for salmon. Overlap of fisheries is minimal for most of species. The primary source of external disturbance to the other pinniped category would be related to the subsistence harvest.

- **Reasonably Foreseeable Future Effects**. State-managed fisheries could be expected to continue at a level similar to the baseline condition. Disturbance from subsistence harvest activities in future years would be expected to be similar to the baseline conditions.

- **Cumulative Effect**. The combined effects of disturbance levels resulting from internal and external effects are found to be insignificant for all species based on very limited overlap with the fisheries and the lack of evidence that disturbance has a population-level effect for any of these species.

Direct/Indirect Effects PA.2 – Other Pinnipeds

For species within the other pinniped group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects PA.2 – Other Pinnipeds

For species within the other pinniped group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

4.9.8.6 Transient Killer Whales

Direct/Indirect Effects PA.1 – Transient Killer Whales

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, PA.1 is not likely to result in significant changes to the population trajectory of killer whales. Six commercial fisheries in Alaska that could have interacted with transient killer whales from the western and GOA stock were monitored for incidental take by fishery observers from 1990 to 1999. Of the observed fisheries (BSAI and GOA groundfish trawl, pot, and longline), killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Angliss *et al.* 2001) (Table 4.5-60). In addition to mortalities caused by entanglement, killer whales are susceptible to injury or mortality through vessel strikes. One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002). The mean annual mortality of killer whales incidental to groundfish fisheries from 1995 to 1999 was estimated to be 1.4 whales (Angliss *et al.* 2001). It is not known what proportion of these whales were transients versus residents. Increased harvest rates under PA.1 may result in the increased take of less than one killer whale relative to the baseline, for a total estimated average of less than two animals per year. Interactions which result in the entanglement of killer whales in fishing gear are rare and are not expected to have population-level effects. Therefore, takes and entanglements of killer whales incidental to groundfish fisheries under PA.1 are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The diet of transient killer whales consists of marine mammals. The diet of transient killer whales consists of marine mammals. Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant under PA.1.

Spatial and Temporal Concentration of the Fishery

The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant under FMP 1.

Disturbance

PA.1 retains the area closures contained under the baseline. The management regime under PA.1 is not expected to result in increased disturbance to killer whales relative to the baseline and is rated insignificant.

Cumulative Effects PA.1 – Transient Killer Whales

The past/present effects on the transient killer whales are described in Section 3.8.22 (Table 3.8-22) and the predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance, with the major indirect effects being the change in the prey availability and the change in the spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. With regard to incidental take and entanglement, PA.1 is not likely to result in changes to the population trajectory of transient killer whales and is considered insignificant.

- **Persistent Past Effects**. Mortality has been documented in the JV, domestic groundfish and state-managed fisheries, and intentional shootings have been known to occur. Past incidental take in the groundfish fisheries is less than two animals per year, but its not known if these animals were transients or residents. In addition to mortalities caused by entanglement, killer whales are susceptible to injury or mortality through vessel strikes. The EVOS resulted in the loss of half of the individual killer whales from the AT1 pod in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and protection as a depleted stock under the MMPA. Contaminant levels in whales in this group were found to be many times higher than others killer whales (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects**. Future mortality is expected from external factors such as state-managed fisheries, intentional shooting, and marine pollution, particularly persistent organic pollutants such as DDT and PCBs (Matkin *et al.* 2001).

- **Cumulative Effects**. Cumulative effects of mortality resulting from internal effects of the groundfish fisheries and external factors are determined to be insignificant. The exception to this finding is in the AT1 transient group in PWS. The cumulative effects of mortality on this group were determined to be significantly adverse due to the past external effects of the EVOS and the subsequent population decline of the AT1 transient group.

<u>Prey Availability</u>

- **Direct/Indirect Effects**. Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant.

- **Persistent Past Effects**. Since marine mammals are the primary prey of transient killer whales, all of the factors that have been identified as affecting the abundance or distribution of cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include commercial and subsistence harvest, intentional shootings, incidental take in all fisheries, marine pollution, climate change, and regime shifts. In addition, there is the potential for past indirect effects of fisheries on the abundance of Steller sea lions, fur seals, and harbor seals, all of which are important prey species for transient killer whales. Declines in harbor seals in PWS after the EVOS could have affected the AT1 group of transient killer whales through their food supply (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects**. Future external effects on prey species important to transient killer whales would include state-managed fisheries to a small extent and subsistence harvest of the various marine mammals.

- **Cumulative Effects**. The cumulative effects on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may specialize on particular prey species, the ability of these top predators to switch prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey. The overall availability of prey does not appear to be having population level effects on transient killer whales and therefore the cumulative effect is considered insignificant.

<u>Spatial and Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects**. The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant.

- **Persistent Past Effects.** All persistent past effects that have been identified for cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include the potential contribution of the spatial/temporal concentration of past fisheries to have caused localized depletion of prey for Steller sea lions, harbor seals, and northern fur seals with consequent population-level effects on those species.

- **Reasonably Foreseeable Future External Effects**. The future spatial/temporal concentration of external fisheries could have indirect effects on the abundance and distribution of marine mammals that are important prey for transient killer whales.

- **Cumulative Effects**. The cumulative effects of the spatial/temporal concentration of fisheries on different marine mammal species result in changes to the abundance and distribution of prey to transient killer whales. Since transient killer whales. are able to switch prey and forage over vast areas, the potential localized depletion of any one species or stock of marine mammal prey is unlikely to have population level effects on the killer whales. The cumulative effect of the spatial and temporal harvest of fish from all fisheries does not appear to be having population level effects on transient killer whales and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects**. Levels of disturbance to killer whales are expected to be similar to baseline conditions and are expected to be insignificant.

- **Persistent Past Effects**. Some levels of disturbance have likely occurred from foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Vessel traffic external to the fisheries has contributed to overall disturbance of these animals. Effects of the level of disturbance on transient killer whales is largely unknown.

- **Reasonably Foreseeable Future External Effects**. External effects of state-managed fisheries and other vessel traffic on disturbance will likely occur in future years at a level similar to the baseline.

- **Cumulative Effects**. Cumulative effects of disturbance levels on transient killer whales resulting from internal and external factors are considered insignificant and are not likely to have any population-level effects.

Direct/Indirect Effects PA.2 – Transient Killer Whales

For transient killer whales, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects PA.2 – Transient Killer Whales

For the transient killer whales, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under PA.2 are the same as discussed under PA.1.

4.9.8.7 Other Toothed Whales

Direct/Indirect Effects PA.1 – Other Toothed Whales

Incidental Take/Entanglement in Marine Debris

Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels and are thought to be insignificant to toothed whale populations. The highest incidental take rate for any cetacean is that of Dall's porpoise. From 1995 to 1999 an average of 8.8 Dall's porpoise were estimated to have been taken incidental to groundfish fishing activities. The majority of these were taken in BSAI trawl fisheries while 1.6 and 1.2 animals were taken in BSAI longline and GOA trawl fisheries respectively. Three harbor porpoise moralities were observed incidental to BSAI groundfish trawl fisheries from 1995 to 1998. The mean annual mortality of Pacific white-sided dolphins incidental to groundfish fisheries from 1995 to 1999 was estimated to be less than one animal with reported takes occurring only in the BSAI longline fishery (Angliss *et al.* 2001) (Table 4.5-60). The estimated mean annual mortality of beluga whales, endangered sperm whales, and beaked whales incidental to groundfish fisheries was zero from 1995 to 1999.

Ten non-lethal interactions with endangered sperm whales have been documented in the GOA longline fishery targeting sablefish in management zones 640 and 650 (Hill *et al.* 1999). Two of the three entanglements reported between 1997 and 2000 resulted in release of the animal without serious injury. The extent of the injuries to the third animal was not known though it was alive at the time of release. No sperm whale mortalities have been observed or reported in the BSAI/GOA groundfish fisheries since observers began collecting data in 1990 (Angliss and Lodge 2002).

In the observed fisheries (BSAI and GOA groundfish trawl, pot, and longline), killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Angliss *et al.* 2001). The mean annual mortality of killer whales incidental to groundfish fisheries from 1995 to 1999 was estimated to be 1.4 whales (Angliss *et al.* 2001). It is not known what proportion of these whales were transients versus residents. Interactions which result in the entanglement of killer whales in fishing gear are rare and are not expected to have population-level effects.

The level of incidental takes and entanglement of toothed whales from groundfish fishing under PA.1 is expected to be rare and is not expected to affect the population trajectories of any species, and is therefore insignificant at the population level.

Fisheries Harvest of Prey Species

The effects of the fisheries on toothed whale prey are largely constrained by differences between their prey and the fisheries harvest targets. PA.1 is not expected to increase the level of competitive interactions for prey from the baseline condition and is therefore determined to have insignificant effects on prey of toothed whales.

The beluga whale stocks along the western coast of Alaska from Bristol Bay north, and in Cook Inlet are generally restricted to shallow coastal and estuarian habitats not used by commercial groundfish fisheries. Their diet is predominantly salmonids and small schooling fishes such as eulachon and capelin. These species are taken only in small quantities as bycatch in the groundfish fisheries. Thus, it is unlikely that fishery interactions exist between beluga whales and Alaskan groundfish fisheries.

Similarly, Pacific white-sided dolphins are not commonly observed north of the Aleutian Islands, and appear to be seasonal visitors in parts of the GOA and southeast Alaska. The main body of their population is more commonly found in the central North Pacific Ocean (Ferrero and Walker 1996). With regard to diet, Pacific white-sided dolphins and Dall's porpoise feed mainly on cephalopods and small schooling fishes such as myctophids. These species are taken only in small quantities as bycatch in the groundfish fisheries.

The remaining species consume a wide variety of both fish and invertebrate species, but overlap with commercially important species is limited in most cases. Beaked whales, a diverse group unto itself, are poorly known, but available information suggests that they prey on benthic and epibenthic species including squid, skates, rattails, rockfish, and octopus. Harbor porpoise diet in Alaskan waters is also poorly understood, although forage consumed by stocks in the Pacific Northwest and their tendency toward near shore distribution suggest that they probably consume a variety of coastal species. None of these species are taken in significant quantities in the groundfish fisheries.

Sperm whale diet overlaps with commercial fisheries targets more than any other species in this group, but the degree of overlap is at least partly due to direct interactions with longline gear. In addition to consuming primarily medium to large sized squids, they also consume salmonids, rockfish, lingcod and skates, and in the GOA they have been observed feeding off longline gear targeting sablefish and halibut. The interaction with commercial longline gear does not appear to have an adverse impact on sperm whales since no mortalities have been observed. On the contrary, the whales appear to have become more attracted to these vessels in recent years as reliable and easy sources of food.

Most information regarding resident killer whale consumption of commercially important groundfish results from observations of whales depredating longlines as they are retrieved in locations ranging from the southeastern Bering sea to PWS. In the waters between Unimak Pass and the Priblof Islands, killer whales regularly strip sablefish and Greenland turbot from longlines. Consumption of other groundfish species by resident killer whales not interacting with gear is largely unknown. In general, they are opportunistic feeders with diets that differ both regionally and seasonally. Nishiwaki and Handa (1958) examined killer whale stomach contents from the North Pacific and found squid, fish, and marine mammals. The importance of these prey items in the BSAI or GOA groundfish management areas is uncertain, but there is no evidence to suggest exclusive reliance on commercially important groundfish species.

Spatial and Temporal Concentration of the Fishery

As stated above, groundfish fisheries have little competitive overlap with toothed whales. The spatial and temporal concentration of the fisheries under PA.1 are expected to be similar to the comparative baseline conditions, which are considered to have insignificant effects on endangered sperm whales and other toothed whales at the population level.

Disturbance

Disturbance of endangered sperm whales and other toothed whales under the PA.1 management regime is not expected to change relative to the baseline and is rated insignificant.

Cumulative Effects PA.1 – Other Toothed Whales

The past/present effects on the other toothed whale group are described in Sections 3.8.19 through 3.8.21 and Sections 3.8.23 through 3.8.25 (Tables 3.8-19 through 3.8-25) and the predicted direct/indirect effects of the groundfish fishery under the PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. The level of mortality for endangered sperm whales and other toothed whale species related to groundfish fishing activities is rare and is not expected to affect the population trajectories of any of these species. Therefore PA.1 is rated as insignificant at the population level.

- **Persistent Past Effects**. Persistent past effects on species within the other toothed whale group include incidental take and entanglement in foreign, JV, Federal domestic groundfish fisheries and state-managed fisheries, and subsistence hunting on beluga whales. The decline of the Cook Inlet beluga population is thought to have been the result of subsistence harvests, which ranged from 21 to 123 animals per year between 1993 and 1998. Only one beluga was harvested in 2001 by hunters from the Native village of Tyonek and one beluga was harvest in 2002 by the Cook Inlet community hunters. Belugas are incidentally taken by the state-managed salmon gillnet fisheries in Bristol Bay and Cook Inlet. However, one beluga was reported to be taken from the EBS in 1996 and seven were reported taken in Bristol Bay in 2000. In the BSAI and GOA groundfish fisheries, no mortality or serious injuries to belugas have been observed. Harbor porpoise have not been taken in the observed groundfish fisheries over a ten year period between 1990 to 1998 (Angliss *et al.* 2001). Salmon gillnet fisheries in southeast Alaska take approximately three individuals per year. Dall porpoise mean annual mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery. The Alaska Peninsula/Aleutian Island salmon drift gillnet fishery has a higher take of Dall's Porpoise, with an estimated 28 porpoises in one year (1990). Thousands of Pacific white-sided dolphins were killed annually between 1978 and 1991 in the high seas driftnet fisheries, which no long occur (Angliss *et al.* 2001). One Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery during the same time span (Angliss *et al.* 2001). State-managed salmon gillnet fisheries take approximately two dolphins per year.

  Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987. The highest counts occurred in 1968 when 16,357 sperm whales were harvested after which the population became severely depleted. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. Sperm whales have been known to prey on sablefish caught on commercial longline gear in the GOA. Only three entanglements have been reported in the GOA longline fishery.

  For killer whales, the combined mortality from the observed groundfish fisheries was 1.4 whales per year (Angliss *et al.* 2001). While it is most likely that whales interacting with fisheries are from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks.

For beaked whales (Baird's, Cuvier's, or Stejneger's), no incidental take or entanglement in the BSAI and GOA groundfish trawl, longline, and pot fisheries has been documented (Hill and DeMaster 1999).

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries were identified as potential sources of mortality in the future. Several of the toothed whale species range outside of the BSAI and GOA during the winter months. Subsistence take of some stocks of beluga whales would be expected to occur in the future. Other species are not taken for subsistence purposes.

- **Cumulative Effect**. Cumulative effects of mortality resulting from internal and external factors are considered insignificant for all non ESA-listed species due to the low level of incidental take in the groundfish fisheries and limited external human-caused mortality.

  For the endangered sperm whale, the cumulative effect was also considered insignificant because the very low level of incidental take in the groundfish fisheries and very limited human-caused mortality from external sources is not expected to delay the recovery of sperm whale populations.

Prey Availability

- **Direct/Indirect Effects**. The groundfish fishery under PA.1 is not expected to increase the level of competitive interactions for toothed whale prey from the baseline condition and is therefore considered to have insignificant effects on toothed whale prey..

- **Persistent Past Effects**. Although this group preys on a wide variety of fish species, past effect on the availability of prey for this group are identified for fisheries in general, and include the foreign, JV, and federal domestic groundfish fisheries, and the state-managed fisheries for salmon and herring. The diversity of diet in this whale group results in limited overlap for most species with the possible exception of sperm whales and resident killer whales.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries were identified as external factors having a potential effect on prey for these species in the future. Climate and regime shifts are identified, but the direction and magnitude of these effects are difficult to predict.

- **Cumulative Effects**. The ability of these whale species to forage over wide areas and on a variety of prey species moderates any potential impacts from fisheries competition. Cumulative effects on prey availability were identified for this group, including a very limited contribution from the groundfish fishery, but the degree of fishery harvest and bycatch of prey important to these whale species is not expected to have population-level effects on any species, including the endangered sperm whale, and is therefore considered insignificant.

Spatial and Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects**. Spatial and temporal fishing measures under PA.1 do not deviate from the baseline, which do not appear to be causing localized depletion of prey for any species of toothed whale, and are thus determined to be insignificant.

- **Persistent Past Effects**. The spatial/temporal concentration of foreign, JV, and domestic groundfish fisheries and the state-managed fisheries are believed to have had minimal effects on the abundance and distribution of toothed whale prey.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries are expected to continue in manner similar to the baseline conditions. Effects of future fishing activities on toothed whale prey are expected to be minimal.

- **Cumulative Effects**. The ability of toothed whales to forage over wide areas and on a variety of prey species moderates any potential impacts from localized depletion of prey from the spatial/temporal concentration of fisheries. Cumulative effects on prey abundance and distribution, including a very limited contribution from the groundfish fishery, are not expected to have population-level effects on any species, including the endangered sperm whale, and are therefore considered insignificant..

Disturbance

- **Direct/Indirect Effects**. Disturbance levels resulting from the groundfish fishery under PA.1 are determined to be insignificant at the population level.

- **Persistent Past Effects**. Past potential disturbance effects on species in this group include foreign, JV, and federal domestic groundfish fisheries; however, there is little indication of a adverse effect at this level of disturbance. General vessel traffic likely contributes to disturbance to these species.

- **Reasonably Foreseeable Future External Effects**. Increases in the general marine vessel traffic and continued fishing activity in the state-managed fisheries were identified as potential sources of disturbance.

- **Cumulative Effects**. The cumulative effect of disturbance from both internal and external factors is found to be insignificant for endangered sperm whales and other toothed whale species based on the lack of evidence that disturbance has a population-level effect for any of these species. For sperm whales, there is growing evidence that the whales are attracted to fishing vessels as reliable and easy sources of food.

Direct/Indirect Effects PA.2 – Other Toothed Whales

For species within the other toothed whales group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects PA.2 – Other Toothed Whales

For species within the other toothed whales group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under PA.2 are the same as discussed under PA.1.

4.9.8.8 Baleen Whales

Direct/Indirect Effects PA.1 – Baleen Whales

Incidental Take/Entanglement in Marine Debris

Take of baleen whales incidental to groundfish fishing activities is rare. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Humpback whales are occasionally taken in the Bering Sea pollock trawl fishery through entanglement in fishing gear. The extent of interaction between bowhead whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. The extent of interaction between gray whales and the groundfish fishery is not known, but some entanglement in gear does occur. Since 1989, no incidental takes of right whales are known to have occurred in the North Pacific.

With respect to incidental take and entanglement in marine debris incidental to groundfish fisheries, PA.1 is not expected to result in significant effects on the population trajectories of any baleen whales, does not conflict with the goals of any recovery plan for endangered whales, and is thus insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Most baleen whale species such as blue, fin, sei, and northern right whale feed primarily on copepods, euphausiids and amphipods. Gray whales feed mostly on epibenthic and benthic invertebrates, while humpbacks and minke whales have a more diverse diet including euphausiids, Atka mackerel, sand lance herring, and capelin. The BSAI and GOA groundfish fisheries do not target these prey items (with the exception of Atka mackerel) and take very small amounts of these prey species as bycatch. Neither the abundance nor distribution of zooplankton are substantially influenced by commercial fishing operations. While a few species of baleen whales do consume herring and juvenile pollock (e.g., humpback and fin whales), changes in removal patterns of these prey species under PA.1 would not be expected to impact their availability to whales, which can forage over vast areas and throughout the water column. The groundfish fisheries under FMP 1 are therefore unlikely to impact baleen whales through competition for prey, including the endangered blue, fin, bowhead, humpback, sei and northern right whales.

Spatial and Temporal Concentration of the Fishery

Spatial and temporal fishing measures under PA.1 do not deviate from the baseline, which does not cause localized depletion of prey for baleen whales, and are therefore determined to be insignificant to both the endangered and non ESA- listed baleen whales according to the criteria established in Table 4.1-6.

Disturbance

The effects of disturbance caused by vessel; traffic, or sound production on baleen whales in the GOA and BSAI are largely unknown. With regard to vessel traffic, most baleen whales appear tolerant, at least as suggested by their reactions at the surface. Observed behavior ranges from attraction to course modification or maintenance of distance from the vessel. Reaction to gear, such as pelagic trawls is unknown, although the rarity of incidental takes suggests either partitioning, or avoidance. Given their distribution throughout the fishing grounds, at least some individuals may be expected to occasionally avoid contact with vessels or fishing gear, which would constitute a reaction to a disturbance. Assuming these instances occur, the effects are likely to be temporary.

Coincident to fishing activity, as well as vessel transit, is the routine use of various sonar devices. The sounds produced by these devices may be audible to baleen whales and suggest disturbance sources. For instance, wintering humpback whales have been observed reacting to sonar pulses by moving away (Maybaum 1990, 1993), although few other cases of reaction have been documented. Given the continued occupation fo the fishing rounds by these animals. And their generally positive population trends, disturbance from sonar, if it occurs in the BSAI or GOA does not appear to have population-level effects. Disturbance of both endangered and non ESA-listed baleen whales under the PA.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

Cumulative Effects PA.1 – Baleen Whales

The past/present effects on the other baleen whale group are described in Section 3.8.11 to Section 3.8.18 (Tables 3.8-11 through 3.8-18), and the predicted direct/indirect effects of the groundfish fishery under the PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. The low level of take and entanglement of baleen whales projected to occur under the PA.1 is considered insignificant at the population level.

- **Persistent Past Effects.** Commercial whaling in the last century has had lingering effects on most of the baleen whales in this group, with the possible exception of the minke whale. These include the endangered blue whales, fin whales, sei whales humpback whales, northern right whales and the non-ESA listed gray whale. Subsistence whaling has also affected several of the baleen whales in the past. Gray whales are harvested both in Alaska and in Russia and have a 5-year quota of 620 whales. The 1968-1993 average take for Russian and Alaska Natives combined was 159 whales per year. Bowhead whales are harvested under International Whaling Commission quotas which allow up to 67 strikes per year although actual strikes have been less than the quota since 1978. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Fin whales were reported in this region year-round, most often in the summer and autumn (POP 1997). Humpback whales are present year-round in Alaska waters but are most frequently reported during the summer and autumn. In 1997, a dead humpback was found entangled in netting and trailing orange buoys near the Bering Strait. It is often difficult to determine if the entanglement occurred with active or derelict gear, or to identify the fishery the derelict gear originated from. Two mortalities (October 1998 and February 1999) were reported by observers in the Bering Sea pollock trawl fishery operating near Unimak Pass. The extent of interactions between bowhead whales and the groundfish fishery are not known. Bowhead whales are present in the Bering Sea during winter and early spring but are usually associated with ice-covered regions. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Of 236 bowhead whales examined from the Alaskan subsistence harvest (from 1976 to 1992), three had visible ship-strike injuries from unknown sources and six had ropes attached or scars from fishing gear (primarily pot gear), one found dead was entangled in ropes similar to those used with fishing gear in the Bering Sea (Philo *et al.* 1992). Since 1992, additional bowhead whales have been observed entangled in pot gear or with scars from ropes. The extent of interactions between gray whales and the groundfish fishery are not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Since 1997, five entanglements (mostly in pot gear) and one ship strike mortality have been reported in Alaska waters. Since 1989, no incidental takes of right whales are known to have occurred in the North Pacific. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. Because the right whale population is believed to be very small, any mortality incidental to commercial fisheries would be considered to be significant. Based on the lack of reported mortalities of endangered right whales, the estimated annual mortality rate incidental to commercial fisheries is zero whales per year from this stock.

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries are expected to continue to take small numbers of baleen whales in the coming years. Entanglement in fishing gear will continue to effect baleen whales throughout their ranges. Subsistence use of gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects**. Cumulative effects of mortality resulting from internal effects of the fishery and contributions from external factors are considered conditionally significant adverse for fin, humpback, and northern right whales due to past effects on their population, potential for interactions with fisheries, and their endangered status. Right whales are very rare so even one human-caused mortality could be considered significant. Given the overlap of their preferred habitat with the BSAI fisheries, the chances of future adverse interactions with fishing gear are more than negligible. The adverse rating for these three species is conditional on whether future take or entanglement substantially affects their rates of recovery. Cumulative effects are found to be insignificant for the endangered blue, bowhead, and sei whales. These species rarely interact with the fisheries so population-level effects are not anticipated. Mortality is also considered insignificant for non-ESA-listed minke and gray whales. Population-level effects are not expected for either of these species.

Prey Availability

- **Direct/Indirect Effects**. The effects of PA.1 are determined to have an insignificant effect on baleen whale prey species due the lack of competitive overlap in prey species targeted by the fisheries.

- **Persistent Past Effects**. Persistent past effects on availability of prey were not identified due to the lack of competitive overlap in prey species targeted.

- **Reasonably Foreseeable Future External Effects**. Future external effects were identified as state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species are not expected to be impacted through their prey.

- **Cumulative Effects**. Cumulative effects on prey availability resulting from internal effects of the fisheries and contributions from external factors are insignificant primarily due to the limited overlap of prey species within the fisheries.

Spatial and Temporal Concentration of the Fishery

- **Direct/Indirect Effects**. Spatial and temporal concentrations under the PA.1 do not deviate substantially from the baseline, thus the effects of the spatial and temporal concentration of the fisheries under PA.1 are determined to be insignificant.

- **Persistent Past Effects**. Persistent past effects associated with spatial/temporal concentration of the fisheries were not identified.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries would be expected to contribute to the change in the spatial/temporal concentration of some prey species within the baleen whales group.

- **Cumulative Effects**. Cumulative effects on the spatial and temporal concentration of harvest of baleen whale prey resulting from internal effects of the fishery and contributions from external factors are considered insignificant for endangered and non-ESA listed species in this group due to the limited overlap of prey species within the fisheries.

Disturbance

- **Direct/Indirect Effects**. Levels of disturbance similar to the baseline condition are expected under PA.1 and are considered insignificant.

- **Persistent Past Effects**. Some level of disturbance has likely occurred from foreign, JV, and domestic groundfish fishing, and state-managed fisheries along with general vessel traffic. For some species, such as the gray whale and bowhead whale, subsistence activities have contributed to disturbance of these animals.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries and general vessel traffic, from recreational boating and whale watching to commercial vessels, would be expected to continue in future years, as well as subsistence activities.

- **Cumulative Effects**. Cumulative effects of disturbance resulting from internal and external sources are determined to be similar to the baseline condition and not likely to result in a population-level effect for any of the species in this group. Therefore, the cumulative effect is considered to be insignificant for both endangered and non ESA-listed baleen whales.

Direct/Indirect Effects PA.2 – Baleen Whales

For species within the baleen whales group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects PA.2 – Baleen Whales

For the baleen whale group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under PA.2 are the same as discussed under PA.1.

4.9.8.9 Sea Otters

Direct/Indirect Effects PA.1 – Sea Otters

Incidental Take/Entanglement in Marine Debris

Sea otter interactions with fishing gear, either passive or active are infrequent. Laist (1997) reported that sea otter entanglement in marine debris is rare. Likewise, incidental takes in fishing gear occur at a rate too low to cause population level effects. While the PBRs for the three sea otter stocks in Alaska were 871 (southeast), 2,095 (southcentral) and 5,699 (southwest), mortalities incidental to commercial fishing were zero, less than one, and less than two per year, respectively (Angliss and Lodge 2002).

In southwest Alaska, the North Pacific Groundfish Observer Program reported eight kills in the Aleutian Islands black cod pot fishery in 1992. No other sea otter kills were reported by NOAA observers in the region from 1990 to 1996. In the 2000 *List of Fisheries,* sea otters were added to the BSAI groundfish trawl as a species recorded as taken in this fishery. The USFWS is currently pursuing information regarding the extent of that possible interaction. The total fishery caused mortality and serious injury for the Alaska sea otter is considered to be insignificant (i.e., will not affect population trajectories). The effects on sea otters under the PA.1 are considered insignificant, with respect to incidental catch and entanglement in marine debris.

Fisheries Harvest of Prey Species

The effect of PA.1 on sea otters is limited by differences between their prey and the species targeted and taken as bycatch by the fisheries.. Sea otters consume a wide variety of prey species, including annelid worms, crabs, shrimp, mollusks (e.g., chitons, limpets, snails, clams, mussels, and octopus), sea urchins, and tunicates. Occasionally, groundfish (e.g., sablefish, rock greenling, and Atka mackerel) may also be consumed, but invertebrates are considered the predominant elements of their diet (Kenyon 1969, USFWS 1994). Given the minor importance of groundfish in their diet, fishery harvests under PA.1 are not expected to have significant effects on the abundance of sea otter prey relative to the baseline and are therefore determined to be insignificant for sea otters.

Spatial and Temporal Concentration of the Fishery

The grounds for suggesting competition for forage between sea otters and commercial fisheries is weak despite the species broad geographical distribution in the GOA and the Aleutian Islands. Sea otters inhabit waters of the open coast, as well as bays and the inside passages of southeastern Alaska. Since their primary prey items are found on the bottom in the littoral zone, to depths of 50 m, the majority of otters feed within one km of the shore (Kenyon 1969). In areas where shallow waters extend far offshore (e.g., Unimak Island), sea otters have been reported as far as 16 km offshore. They are often seen resting and diving for food in and near kelp beds (Kenyon 1969). Because of this habitat preference for shallow areas, they do not overlap spatially with groundfish fisheries. Since the spatial and temporal concentration of the fisheries under PA.1

is expected to be similar to the baseline, which does not appear to affect the localized abundance of sea otter prey, PA.1 is considered to be insignificant for this effect on sea otters.

Disturbance

As noted for many of the other marine mammals, the effects of disturbance caused by vessel traffic, fishing operations, or sound production on sea otters in the GOA and BSAI are expected to be insignificant. Sea otters exhibit considerable tolerance for vessel traffic, and in some cases are attracted to small boats (Richardson *et al.* 1995). Sea otters may be more tolerant of underwater sound relative to other species, owing to the greater amount of time they spend at the surface. Levels of disturbance under PA.1 are expected to be similar to the baseline level and are therefore considered insignificant for sea otters.

Cumulative Effects PA.1 – Sea Otters

The past/present effects on the sea otter are described in Section 3.8.10 (Table 3.8-10) See Table 4.9-5 for a summary of the direct/indirect and cumulative effects. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects being the change in prey availability and the change in the spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. The effects of incidental take and entanglement on sea otters under PA.1 are considered insignificant.

- **Persistent Past Effects.** Commercial exploitation for pelts had a large impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Protective measures instituted in 1911 have allowed remnant groups to increase and reoccupy much of the historic sea otter range in Alaska (Kenyon 1969, Estes 1980). Residual effects from this early harvest likely persist in several areas. Alaska Natives have hunted sea otters for pelts and meat throughout history. Current harvest levels represent nine percent of PBR for the southwestern stock, 15 percent of PBR for the southcentral stock, and 35 percent of PBR for southeast stock. (USFWS 2002a. 2002b, and 2002c). In 1992, fisheries observers reported eight sea otters taken incidentally by the Aleutian Island black cod pot fishery. During that year, only a third of the fisheries were observed, yielding an estimate of 24 otters killed in cod pot gear. No other sea otter takes were reported from observed fisheries in the range of the southwest stock from 1993 through 2000. In 1997, one sea otter was self-reported to be taken in the BSAI groundfish trawl fishery (USFWS 2002a, 2002b, and 2002c). Oil spills, such as the EVOS, can result in substantial mortality of sea otters. Sea otter numbers have declined dramatically from the Alaska Peninsula to the Bering Sea and this stock is being considered for listing under the ESA.

- **Reasonably Foreseeable Future External Effects.** Low-levels of incidental take in commercial and subsistence fisheries, subsistence hunting, and periodic mortalities from oil spills are likely to continue in the future. Population level effects from killer whale predation may continue in the southwest Alaska stock, depending on the recovery of alternate prey and behavior of transient killer whales.

- **Cumulative Effects**. The cumulative effects of mortality from all sources are different for different stocks of sea otters. The populations of the southeast and southcentral stocks of sea otters appear to be stable or increasing and are not expected to have additional mortality pressure in the future. These stocks are considered to have insignificant cumulative effects from mortality. The rapid decline of the southwest Alaska stock does not appear to be the result of food shortages, disease, or toxic contamination and is likely the result of increased predation by transient killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al.* 1998). Since the mechanism(s) of the population decline is still under investigation, the cumulative effect on the southwest stock is considered to be conditionally significant adverse for mortality.

<u>Prey Availability</u>

- **Direct/Indirect Effects.** The effects of the PA.1 on sea otters is limited by differences between their prey and the fisheries harvest targets. As such, the effects of harvest of key prey species in groundfish fisheries are determined to be insignificant for sea otters.

- **Persistent Past Effects**. The federal groundfish fisheries have had little effect on the availability of prey in the past due to the limited overlap in prey species of the sea otter and the fish targeted by the groundfish fisheries. There is some minor overlap in state-managed crab fisheries of sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters are identified as external effects. The overlap primarily occurs in inshore areas or offshore areas with relatively shallow water.

- **Cumulative Effects**. Cumulative effects on prey availability resulting from internal effects of the groundfish fisheries and external factors, such as the crab fisheries, are determined to be insignificant due to the very limited overlap of these fisheries and the sea otter forage species.

<u>Spatial and Temporal Concentration of the Fisheries</u>

- **Direct/Indirect Effects**. Despite the species broad geographical distribution in the GOA and the Aleutian Islands, they do not generally overlap spatially with groundfish fisheries. Therefore, the effects of the spatial and temporal concentration of the fisheries are insignificant for sea otters.

- **Persistent Past Effect**. The limited spatial overlap of groundfish fisheries and other fisheries in the past have limited their interaction with sea otter prey. Past effects of spatial/temporal concentration have likely been in very specific areas and associated with state-managed crab fisheries.

- **Reasonably Foreseeable Future External Effects**. State-managed crab fisheries are likely to continue into the future at a level similar to the baseline conditions.

- **Cumulative Effects**. The cumulative effect of the spatial/temporal harvest of prey in the internal and external fisheries is considered to be insignificant due their limited spatial overlap with sea otter habitat. These fisheries are unlikely to have population-level effects.

Disturbance

- **Direct/Indirect Effects**. Baseline levels of disturbance caused by vessel traffic, fishing operations, or sound production on sea otters in the GOA and BSAI are considered to be insignificant. Levels of disturbance under the PA.1 are expected to be similar to the baseline; therefore, the effects of disturbance on sea otters are expected to be insignificant.

- **Persistent Past Effects**. Past disturbance levels are primarily related to vessel traffic from fisheries and other vessels and disturbance associated with subsistence harvest of sea otters.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue at a level similar to the baseline conditions. Commercial vessel traffic within sea otter habitat in future years would also be expected to be similar the baseline.

- **Cumulative Effects**. Cumulative effects of disturbance on sea otters resulting from internal effects of the groundfish fisheries and external effects of other fisheries are considered insignificant and are unlikely to result in a population-level effect. Contribution of the groundfish fisheries to the overall cumulative effect is minor.

Direct/Indirect Effects PA.2 – Sea Otters

For sea otters, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects

For sea otters, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under PA.2 are the same as discussed under PA.1.

4.9.9 Socioeconomic Preferred Alternative Analysis

This policy alternative would seek to accelerate the existing precautionary management measures through rights-based management and ecosystem-based management principles and, where appropriate and practicable, increase habitat protection and impose additional bycatch constraints. This section contains both quantitative and qualitative analysis of select economic and social effects of PA.1 and PA.2.

In general, the quantitative economic outcomes of this management policy appear nearly identical to those projected under Alternative 1. No significant differences between the two management policies are projected, at least in the variables for which changes are captured by the projection model. Most of the differences between the policies occur in variables that have not been quantified in the analysis such as product prices, harvesting and processing capacity, average costs, and fishing vessel safety.

4.9.9.1 Harvesting and Processing Sectors

The model and analytical framework used in the analysis of the effects of PA.1 on the harvesting and processing sectors are described in Section 4.1.7.

Table 4.9-6 summarizes projected impacts of PA.1 on harvesting and processing sectors. The numbers in the table reflect the five-year average of outcomes projected for 2003 to 2007. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, harvests of this species are estimated to increase by 36 percent, from 218,000 mt to 297,000 mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment, and groundfish payments to labor.

4.9.9.1.1 Catcher Vessels

Direct/Indirect Effects of PA.1

Groundfish Landings By Species Group

A comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 catcher vessel conditions reveals that under PA.1 there would be few significant changes in overall retained harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, retained catches of this species are expected to increase by about 54 percent. In addition, an increase in the TAC for sablefish and rockfish will result in a significant increase in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. This leads to direct/indirect effects ratings of insignificant/significantly beneficial for groundfish landings by species group under PA.1.

Ex-Vessel Value

The total ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by the smaller trawl catcher vessels and pot catcher vessels account for much of the increase in groundfish ex-vessel value. Longline vessels are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase under PA.1, but not significantly.

Impacts on Excess Capacity

A conditionally significant decrease in excess capacity in the harvesting sectors is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the decrease is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. One of the primary reasons for expanding the use of rights-based management is to prevent the build-up of excess harvesting and processing capacity or reduce excess capacity that already exists (NMFS 2001a). Excess capacity both contributes to and is the result of the race for fish, with its associated potential adverse impacts on profitability, product quality, and safety. Rights-based systems, whether they allocate shares of the catch to individuals or groups, are incentive adjusting methods in that they attempt to control capacity by creating economic incentives for owners of vessels to decrease their use of labor and capital rather than by directly regulating the level of fishing effort.

The implementation of additional individual or group-based (e.g., community or cooperative) quota systems that end the race for fish and allow transfer of quota shares would be expected to lead to some consolidation of quota to fewer vessels. The degree of consolidation will vary depending on the level of excess capacity, economies of scale and scope in harvesting, and rules that restrict transfer and accumulation of quota shares (NMFS 2001a). Similar consolidation could occur with expanded use of cooperatives or community quota programs. Some excess capacity, in the sense of an ability of vessels and processors to catch and harvest a TAC in less time than a maximum season length would allow, can be expected to persist regardless of what type of additional rights-based measures are put in place. This is generally the case for a number of reasons. It is often not economically efficient to operate at maximum possible production levels, there are typically certain times of the year when it is more efficient and profitable to harvest and process fish, and alternative uses for fishing and processing capital are limited (NMFS 2001a).

Average Costs

A conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the decrease in average costs is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. Increased rationalization of the fisheries would be expected to reduce the costs of harvesting. Individual vessels will have the opportunity to select the least cost combination of fishing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost-effective harvesting operations. Fixed costs will be reduced by consolidating harvesting operations and retiring or selling-off vessels. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting rights and on the level of excess capacity prior to implementation of remedial measures.

Fishing Vessel Safety

A conditionally significant increase in fishing vessel safety is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the increase in fishing vessel safety is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. Rights-based systems of any kind are expected to improve safety by reducing the pressure to fish under dangerous conditions (NMFS 2001a). The race for fish creates incentives to fish farther from shore or in areas and seasons with more hazardous weather conditions, and requires crew members to work for long stretches with little rest or sleep. Rights-based systems should slow down the pace of fishing and reduce the financial penalty incurred by opting to cease fishing under unsafe conditions. The most important benefit of improved safety will be a decrease in fishery related injuries and loss of life. Other benefits include savings from not having to replace lost vessels and gear. Finally, significant improvements in safety, if they occur, should result in decreased insurance costs for the industry (NMFS 2001a).

At the same time, it is important to recognize that rationalized fisheries do not necessarily guarantee improvements in safety for fishermen. Under an IFQ program, for example, market opportunities or biological conditions (e.g., spawning aggregations) may still encourage fishermen to fish at times or in places that are unsafe.

For a summary of the direct/indirect effects on catcher vessels under PA.1, please see Table 4.9-6.

Cumulative Effects of PA.1

This section assesses the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125), and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. An insignificant change in retained harvest of groundfish relative to the comparative baseline is projected under PA.1, with the exception of sablefish and rockfish, which are likely to increase significantly.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Given the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under PA.1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (54 percent), as well as for sablefish and rockfish. Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under PA.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations as explained in more detail in Section 4.9.1, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Ex-Vessel Value

- **Direct/Indirect Effects**. The total ex-vessel value of groundfish landed by catcher vessels is not expected to increase significantly under PA.1.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market, which contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in ex-vessel value (9 percent) that are predicted for PA.1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from PA.1.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Changes in ex-vessel value relative to the baseline under PA.1 are insignificant.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (9 percent) under PA.1, is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are projected to increase slightly (9 percent) under PA.1, thereby mitigating some of the reductions in other fisheries. These other fisheries are not expected to contribute to cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under PA.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Changes in excess capacity are likely to be conditionally significant beneficial under PA.1.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Under PA.1, the extent to which rights-based management would be implemented in groundfish fisheries is uncertain. Should rights-based management be extended to other groundfish fisheries, excess capacity would be expected to be reduced in those fisheries. Excess capacity currently exists in non-groundfish fisheries to a certain extent as well, and may continue to exist unless management measures are taken to reduce it. Assuming that rights-based management is implemented in additional groundfish fisheries, a conditionally significant beneficial cumulative effect is likely for excess capacity under this FMP (see Appendix F-8).

Average Costs

- **Direct/Indirect Effects**. Conditionally significant beneficial effects are expected to occur for average costs under PA.1.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. The extent to which rights-based management would be expanded is uncertain. Should rationalization programs be implemented average costs would be reduced. Thus, a conditionally significant beneficial cumulative effect is projected for PA.1 as a result of rights-based management that could be implemented.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Conditionally significant beneficial effects are predicted under PA.1.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Should rights-based management be expanded under PA.1, vessel safety could improve due to the end of the race for fish and less pressure to fish under dangerous conditions. Closures implemented in other fisheries may affect vessel safety in the groundfish fisheries, though these closures are not expected to result in a significant cumulative effect on vessel safety. Thus, a conditionally significant beneficial cumulative effect on fishing vessel safety is projected for PA.1 as a result of rights-based management that could be implemented.

Direct/Indirect Effects of PA.2

Table 4.9-6 summarizes projected impacts of PA.2 on harvesting and processing sectors. The numbers in the table reflect the five-year average of outcomes projected for 2003 to 2007. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, harvests of this species are estimated to increase by 29 percent, from 218,000 mt to 281,000 mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment, and groundfish payments to labor.

Groundfish Landings By Species Group

A comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 catcher vessel conditions reveals that under PA.2, there would be a number of significant changes in overall retained harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, retained catches of this species are expected to increase by about 49 percent. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. Bycatch of non-target species and PSC is expected to decrease with incentives included in rationalization programs.

Reducing PSC limits for herring, crab, halibut, and salmon in the BSAI could impact the temporal nature of many fisheries. Fisheries which currently close seasonally because they exceed seasonal PSC limits could have even shorter seasons and possibly harvest less of the TAC if PSC limits are reduced. However, other measures implemented under PA.2 such as increased rationalization may lead to a reduction in prohibited species bycatch rates and thereby lessen the constraints of PSC limits on groundfish fisheries, regardless of whether or not the limits are reduced.

Ex-Vessel Value

The ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by the smaller trawl catcher vessels and pot catcher vessels account for much of the increase in groundfish ex-vessel value. Longline vessels are expected to experience a significant reduction in ex-vessel value due to the decrease in catches of rockfish and sablefish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to decrease under PA.2, but not significantly. Longline vessels account for most of the decrease in employment and payments to labor.

Impacts on Excess Capacity

The comprehensive rationalization program that would be implemented under PA.2 is expected to result in a significant decrease in excess capacity in the harvesting and processing sectors relative to the comparative baseline, leading to a significantly beneficial direct/indirect effect rating. One of the primary reasons for expanding the use of rights-based management is to prevent the build-up of excess harvesting and processing capacity or reduce excess capacity that already exists (NMFS 2001a). Excess capacity both contributes to, and is the result of, the race for fish, with its associated potential adverse impacts on profitability, product quality, and safety. Rights-based systems, whether they allocate shares of the catch to individuals or groups, are incentive adjusting methods, in that they attempt to control capacity by creating economic incentives for owners of vessels to decrease their use of labor and capital rather than by directly regulating the level of fishing effort.

The implementation of additional IFQ programs that end the race for fish and allow transfer of quota shares would be expected to lead to some consolidation of quota to fewer vessels. The degree of consolidation will vary depending on the level of excess capacity, economies of scale and scope in harvesting, and rules that restrict transfer and accumulation of quota shares (NMFS 2001a). Similar consolidation could occur with expanded use of cooperatives or CDQ programs. Some excess capacity, in the sense of an ability of vessels and processors to catch and harvest the TAC in less time than a maximum season length would allow, can be expected to persist regardless of what type of additional rights-based measures are put in place. This is generally the case for a number of reasons. It is often not economically efficient to operate at maximum possible production levels; there are typically certain times of the year when it is more efficient and profitable to harvest and process fish; and alternative uses for fishing and processing capital are limited (NMFS 2001a).

Average Costs

Possible increased area closures to protect habitat as well as restrictions on bottom trawling for pollock are likely to increase average costs. The comprehensive rationalization program is expected to significantly reduce costs, leading to conditionally significant adverse/significantly beneficial direct/indirect effects ratings. The significance of the increase in average costs is conditional because it is uncertain to what extent PA.2 would create marine protected areas and no-take reserves to protect habitat. If additional area closures are implemented, the spatial displacement of fishing effort could be large for some bottom trawl fisheries. Operating costs would be expected to increase as vessels must travel further to fish, and gross revenue may decline as vessels may be required to fish in less productive areas.

Restrictions on bottom trawling for pollock are likely to increase average costs. It is reasonable to assume that, subject to regulatory constraints, harvesters target catch with the gear that maximizes its value either by increasing the value (quality) of the fish or by decreasing the harvesting cost or both. To the extent that the historical fishing gear was used because it has the lowest cost per unit of catch, the prohibition on bottom trawling for pollock in the GOA would result in increased cost per unit of catch for those fishing vessels that switch to pelagic trawling. Moreover, these vessels would have to purchase new gear and learn to use it. For vessels that use bottom trawl gear exclusively, the conversion necessary to fish with pelagic trawl gear would be substantial in some cases. In addition to new trawl gear, the conversion could include a more powerful engine, new gear handling equipment on deck, and new electronics.

Increased rationalization is expected to reduce the costs of harvesting. Individual vessels will have the opportunity to select the least cost combination of fishing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective harvesting operations. Fixed costs will be reduced by consolidating harvesting operations and retiring or selling off vessels. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting rights and on the level of excess capacity prior to implementation of remedial measures.

Fishing Vessel Safety

A significant improvement or a conditionally significant reduction in fishing vessel safety could occur under PA.2 relative to the comparative baseline, leading to a significantly beneficial/conditionally significant adverse direct/indirect effects ratings. The significance of the decrease in vessel safety is conditional because it is uncertain to what extent PA.2 would close additional areas as MPAs or no-take reserves. Furthermore, the net effect of the various measures on fishing vessel safety is uncertain. The comprehensive rationalization program is expected to promote vessel safety by eliminating the race for fish. On the other hand, the spatial closures to protect habitat, if implemented, will limit the areas available for fishing and are likely to force vessels to operate farther from shore and in less than optimal weather conditions.

The implementation of rights-based systems under this FMP is expected to improve safety by reducing the pressure to fish under dangerous conditions (NMFS 2001a). The race for fish creates incentives to fish in areas and seasons with more hazardous weather and sea conditions and requires crew members to work for long stretches with little rest or sleep. Rights-based systems should slow down the fishing and reduce the financial penalty incurred by opting to stop fishing under unsafe conditions. The most important benefit of improved safety will be a decrease in fishery related injuries and loss of life. Other benefits include savings from not having to replace lost vessels and gear. Finally, significant improvements in safety, if they occur, should result in decreased insurance costs for industry (NMFS 2001a). At the same time, it is important to recognize that rationalized fisheries do not necessarily guarantee improvements in safety for fishermen. Under an IFQ program, for example, market opportunities may still encourage fishermen to fish at times or in places that are unsafe.

However, the additional area closures to protect habitat that may be implemented under PA.2 could result in vessels fishing farther from a port. This would decrease fishing vessel safety. Smaller catcher vessels based out of the Alaska Peninsula, Aleutian Islands, and Kodiak communities may be especially exposed to additional risks. These effects could be mitigated somewhat if individual fishing quotas were set aside for smaller vessels to fish in certain nearshore areas.

For a summary of the direct/indirect effects on catcher vessels under PA.2, please see Table 4.9-6.

Cumulative Effects of PA.2

This section assesses the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety.

<u>Groundfish Landings By Species Group</u>

- **Direct/Indirect Effects**. Insignificant cumulative effects are predicted under PA.2 for most species except for Pacific cod which is expected to increase significantly. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the retained harvests of these species.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Although there are currently reductions in the commercial salmon and crab fisheries, the predicted increases in retained harvest of Pacific cod (49 percent) may help mitigate that effect. Reductions in harvest of the A-R-S-O complex (29 percent) are projected to be significant but could be mitigated by the large increases in Pacific cod. Changes in other economic development activities and other sources of municipal and state revenue are expected to be mitigated by the increase in retained Pacific cod harvests. Overall, cumulative effects on groundfish landings by species group are projected to be insignificant under PA.2.

Ex-Vessel Value

- **Direct/Indirect Effects**. The total ex-vessel value of groundfish landed by catcher vessels is not expected to increase significantly under PA.2. Longline vessels are expected to experience a significant reduction in ex-vessel value due to the decrease in catches of rockfish and sablefish.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. While marginal changes in ex-vessel value in other fisheries may occur in the future, these changes are not expected to cumulatively affect groundfish ex-vessel value significantly. Other economic development activities and other sources of municipal and state revenue are not expected to have a significant cumulative effect on ex-vessel value under PA.2.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Changes in employment and payments to labor relative to the baseline under PA.2 are insignificant.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Given the current reductions in the salmon and crab fisheries, and the fact that many fishermen often participate in multiple fisheries, fewer fishermen may be able to support their participation in the groundfish fisheries as a result of these reductions. However, the opposite result may occur where more harvesters are competing for groundfish employment as a result of reductions in other fisheries. Though these changes may occur, they are not expected to result in significant cumulative effects on groundfish employment under PA.2. Payments to labor in other fisheries are not expected to contribute to cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on payments to labor are projected to be insignificant.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Changes in excess capacity are likely to be significantly beneficial under PA.2.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Under PA.2, the comprehensive rationalization program would significantly reduce excess capacity. Although excess capacity would still remain in other fisheries such as salmon and crab, the program implemented under PA.2 would have such a strong effect that the benefits would far outweigh the effects of overcapacity in other fisheries (see Appendix F-8).

Average Costs

- **Direct/Indirect Effects**. Significantly beneficial or conditionally significant adverse effects are expected to occur for average costs under PA.2.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. As described above, area closures affect average costs through increases or decreases in transit time to fishing areas. If additional closures are implemented under PA.2 to protect habitat, these closures would increase average costs by causing fishermen to travel farther to harvest fish. On the other hand, comprehensive rationalization is likely to significantly reduce average costs. Cost savings depend on the constraints put on the transfer and consolidation of harvesting rights and the level of excess capacity that might still remain in other fisheries. Therefore, significantly adverse or beneficial cumulative effects are possible under PA.2.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Significantly beneficial or conditionally significant adverse effects are predicted for fishing vessel safety under PA.2.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Under PA.2, vessel safety could improve due to the end of the race for fish and rationalization. However, possible additional area closures implemented under PA.2, plus any closures implemented in other fisheries, may adversely affect vessel safety causing vessels to travel farther and in potentially dangerous weather conditions. Therefore, significantly beneficial or adverse cumulative effects are possible under PA.2.

4.9.9.1.2 Catcher Processors

Direct/Indirect Effects of PA.1

Groundfish Landings By Species Group

Comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that under PA.1 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 30 percent. Catches of pollock, flatfish, and A-R-S-O species are not expected to change significantly.

Groundfish Gross Product Value

The overall wholesale product value of groundfish outputs of catcher processors is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by head-and-gut trawl catcher processors, pot catcher processors, and longline catcher processors account for much of the increase in product value. The harvest of Pacific cod by surimi trawl catcher processors and fillet trawl catcher processors is limited by AFA sideboard measures that restrict the participation of AFA-eligible vessels in other groundfish fisheries to some level of historic participation.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under PA.1, but not significantly.

Product Quality and Product Utilization Rate

A conditionally significant increase in product quality and product utilization rates is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the increase in product quality and utilization is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. The race for fish creates incentives to maximize profits per unit of fishing time rather than per unit of fish. Consequently, it may induce wasteful practices or reduce the incentives to increase recovery rates if those increases are costly either in out-of-pocket costs or opportunity costs of time. Even when increased or full utilization is profitable in terms of the value and costs of product, there may be an implicit cost due to storage space limitations that will force more frequent unloading.

For the most part, rights-based systems should give individuals and groups the incentive to get the maximum value out of each unit of catch. Consequently, product quality and utilization rates are expected to increase under this FMP bookend should rights-based management be extended to additional fisheries. Some increases in value can be expected as a result of the improved quality that can be achieved by more careful harvesting and handling practices. In a race for fish these time-consuming practices may be neglected because the opportunity costs are too high. For example, vessels may choose to make shorter tows to reduce the crushing of fish in the codend or may spend more time searching for larger, more valuable fish. The value of production will increase because processors have the time and incentive to make products of higher value, and to retain fish they had previously discarded. For example, in rationalized fisheries head-and-gut trawl catcher processors may be more likely to retain male rock sole and small yellowfin sole because retention of those fish would no longer put vessels at a competitive disadvantage compared to vessels that discard.

Excess Capacity

As with catcher vessels, a conditionally significant decrease in excess capacity in the harvesting and processing sectors is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in excess capacity depends on the extent to which PA.1 extends rights–based management to additional groundfish fisheries.

Average Costs

As with catcher vessels, a conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in average costs depends on the extent to which PA.1 extends rights-based management to additional groundfish fisheries.

Fishing Vessel Safety

As with catcher vessels, a conditionally significant increase in fishing vessel safety is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The increase in fishing vessel safety depends on the extent to which PA.1 extends rights-based management to additional groundfish fisheries.

For a summary of the direct/indirect effects on catcher processors under PA.1, please see Table 4.9-6.

Cumulative Effects of PA.1

This section assesses the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on catcher processors are presented in detail in Section 3.9 (Table 3.9-125), and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Overall, insignificant effects are expected for retained harvests of groundfish species except for Pacific cod which is expected to result in significant increases of the number of landings (30 percent).

- **Persistent Past Effects**. For details on persistent past effects, see Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects**. Given the current downward trends in the commercial salmon and crab fisheries, catcher processors that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under PA.1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (30 percent). Overall, reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under PA.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations as explained in more detail in Section 4.9.1, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects**. The gross product value is not expected to result in significant changes from the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (6 percent) that are predicted for PA.1 may mitigate some of the current declines in other fisheries. For these reasons, insignificant cumulative effects on gross product value are expected to result from PA.1.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Insignificant changes in employment and payments to labor are predicted for catcher processors under PA.1.
- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.
- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.
- **Cumulative Effects**. The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (7 percent) under PA.1, is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are projected to increase slightly (6 percent) under PA.1, thereby, mitigating some of the reductions in other fisheries. These other fisheries are not expected to contribute to significant cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under PA.1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. Conditionally significant beneficial effects in product quality and product utilization rates are expected under PA.1 relative to the baseline.
- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.
- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).
- **Cumulative Effects**. Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has made significant differences in product quality and utilization; however, any continuation of this harvest strategy in fisheries may hinder some of these improvements. To the extent that rights-based management is extended to other fisheries under PA.1, increases in product quality and utilization are expected. Furthermore, increases in product quality and utilization are likely in the long-term given the trend towards improved fishing and preservation techniques. Thus, conditionally significant beneficial cumulative effects are projected under PA.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Conditionally significant beneficial effects in excess capacity are expected under PA.1 relative to the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (see Appendix F-8). Cumulative effects are conditionally significant beneficial because to the extent that a rights-based management regime is extended to other groundfish fisheries under PA.1, excess capacity would be reduced.

Average Costs

- **Direct/Indirect Effects**. Conditionally significant beneficial effects in average costs are expected under PA.1 relative to the comparative baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount, while ex-vessel value and product value are variable. Catcher processors that are dependent on multiple fisheries are often sensitive to changes in other fisheries. Assuming rights-based management extends to other groundfish fisheries under PA.1, average costs would be reduced. Thus, conditionally significant beneficial cumulative effects are predicted on excess capacity under PA.1.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Conditionally significant beneficial effects for fishing vessel safety are expected under PA.1.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, distance to fishing areas and sea conditions relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen; however, these effects are not expected to be significant under PA.1. The extent to which rights-based management is implemented under PA.1 will affect vessel safety. As there are no predicted increases in area closures under PA.1, and assuming rights-based management is extended to other groundfish fisheries, cumulative effects on vessel safety are conditionally significant beneficial compared to the baseline condition.

Direct/Indirect Effects of PA.2

Groundfish Landings By Species Group

A comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that under PA.2 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 22 percent. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. Bycatch of non-target species and PSC is expected to decrease with incentives included in rationalization programs.

Groundfish Gross Product Value

The overall wholesale product value of groundfish outputs of catcher processors is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by head-and-gut trawl catcher processors, pot catcher processors, and longline catcher processors account for much of the increase in product value. The harvest of Pacific cod by surimi trawl catcher processors and fillet trawl catcher processors is limited by AFA sideboard measures that restrict the participation of AFA-eligible vessels in other groundfish fisheries to some level of historic participation.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under PA.1, but not significantly.

Product Quality and Product Utilization Rate

A significant improvement or a conditionally significant reduction in product quality and utilization rates could occur under PA.2 relative to the comparative baseline, leading to significantly beneficial and conditionally significant adverse direct/indirect effects ratings. The significance of the decrease in product quality and utilization is conditional because it is uncertain to what extent PA.2 would establish additional area closures to protect habitat. Furthermore, the net effect of the various measures on fishing vessel product quality and utilization is uncertain.

The implementation of a comprehensive rights-based management program will tend to improve product quality and utilization rates. The race for fish creates incentives to maximize profits per unit of fishing time rather than per unit of fish. Consequently, it may induce wasteful practices or reduce the incentives to increase recovery rates if those increases are costly either in out-of-pocket costs or opportunity costs of time. Even when increased or full utilization is profitable in terms of the value and costs of product, there may be an implicit cost due to storage space limitations that will force more frequent unloading. For the most part, rights-based systems should give individuals and groups the incentive to get the maximum value out of each unit of catch. Some increases in value can be expected as a result of the improved quality that can be achieved by more careful harvesting and handling practices. In a race for fish these time-consuming practices may be neglected because the opportunity costs are too high. For example, vessels may choose to make shorter tows to reduce the crushing of fish in the codend or may spend more time searching for larger, more valuable fish. The value of production will also increase because processors have the time and incentive to make products of higher value, where previously they had focused on products that could be produced quickly or with lower quality fish. For instance, we might expect to see more fillet production in place of round or headed-and-gutted product.

On the other hand, the additional area closures that are implemented under PA.2 may contribute to lower product quality. However, this effect is not likely to offset the gains from rationalization. It is reasonable to assume that, subject to regulatory constraints, harvesters target catch in areas that maximizes its value either by increasing the quality of the fish or by decreasing the harvesting cost or both. Consequently, a measure that prohibits vessels from using historical fishing grounds may result in a decline in product quality (e.g., fish may be smaller or a less uniform size).

Excess Capacity

As with catcher vessels, the comprehensive rationalization program that would be implemented under PA.2 is expected to result in a significant decrease in excess capacity in the harvesting and processing sectors relative to the comparative baseline, leading to a significantly beneficial direct/indirect effect rating. Because the number of catcher processors that are not AFA-eligible out number the vessels that are AFA-eligible, the reduction in excess capacity resulting from rationalization should be significant.

Average Costs

As with catcher vessels, possible increased area closures to protect habitat as well as restrictions on bottom trawling for pollock are likely to increase average costs. The comprehensive rationalization program is expected to significantly reduce costs, leading to conditionally significant adverse/significantly beneficial direct/indirect effects ratings. The significance of the increase in average costs is conditional because it is uncertain to what extent PA.2 would create MPAs and no-take reserves to protect habitat. Furthermore, the net effect of the various measures on average costs is uncertain.

Fishing Vessel Safety

As with catcher vessels, a significant improvement or a conditionally significant reduction in fishing vessel safety could occur under PA.2 relative to the comparative baseline, leading to conditionally significant adverse and significantly beneficial direct/indirect effects ratings. The significance of the decrease in vessel safety is conditional because it is uncertain to what extent PA.2 would close additional areas as MPAs or no-take reserves. Furthermore, the net effect of the various measures on fishing vessel safety is uncertain. The comprehensive rationalization program is expected to promote vessel safety by eliminating the race for fish. On the other hand, the spatial closures to protect habitat, if implemented, will limit the areas available for fishing and are likely to force vessels to operate farther from shore and in less than optimal weather conditions.

For a summary of the direct/indirect effects on catcher processors under PA.2, please see Table 4.9-6.

Cumulative Effects of PA.2

This section assesses the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on catcher processors are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

<u>Groundfish Landings By Species Group</u>

- **Direct/Indirect Effects**. Overall, insignificant changes in groundfish harvests are expected under PA.2; however, significant increases in Pacific cod and significant decreases in sablefish and rockfish are predicted for this FMP.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.

- **Cumulative Effects**. As stated under PA.1, the current downward trends in the commercial salmon and crab fisheries are adversely affecting catcher processors that rely on a mix of fisheries harvests. However, this cumulative effect may not result in significant changes in groundfish landings under PA.2. An increase in TAC for Pacific cod in the BSAI and GOA is expected (22 percent). Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under PA.2. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group.

<u>Groundfish Gross Product Value</u>

- **Direct/Indirect Effects**. The gross product value is not expected to result in significant changes from the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described under PA.1, insignificant cumulative effects on groundfish gross product value are expected to result from PA.2.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Insignificant changes in employment and payments to labor are predicted for catcher processors under PA.2.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Total employment and payments to labor are expected to increase under PA.2. As with catcher vessels, reductions in the salmon and crab fisheries, and the reliance many fishermen have on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (5 percent) under PA.2 may mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (5 percent) under PA.2. Catcher processors that participate in the halibut fishery may be less sensitive to reductions in salmon and crab. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under PA.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. A significantly beneficial or conditionally significant adverse effect on product quality and product utilization rates is possible under PA.2.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has made significant differences in product quality and utilization; however, the additional closures that may be implemented under this FMP may result in a decline in product quality (e.g., fish may be smaller or a less uniform size). Overall, significant beneficial or adverse cumulative effects are possible for product quality and utilization under PA.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. A significantly beneficial effect in excess capacity is expected under PA.2 relative to the baseline. Excess capacity is predicted to decrease significantly.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As with PA.1, comprehensive rationalization in the groundfish fishery will help reduce excess capacity. Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (see Appendix F-8). Assuming that these programs continue in other fisheries and are expanded in the groundfish fisheries under PA.2, significant beneficial cumulative effects are expected for excess capacity.

Average Costs

- **Direct/Indirect Effects**. Various measures under PA.2 are likely to both increase and decrease average costs. The net effect of PA.2 on average costs is unknown (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described in more detail under PA.1, average costs in the groundfish fisheries are often associated or shared with other fisheries and include both fixed costs and variable costs. The effects of comprehensive rationalization under this FMP are likely to reduce costs. However, area closures affect average costs through increases in transit time to fishing areas. It is uncertain to what extent PA.2 would establish additional area closures. Therefore, significantly beneficial or adverse cumulative effects are possible under PA.2.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Significant beneficial or conditionally significant adverse effects for fishing vessel safety are possible under PA.2. The net effect of this FMP on vessel safety is uncertain (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions relative to vessel size. Under PA.2, vessel safety could improve due to the end of the race for fish and rationalization. However, possible additional area closures implemented under PA.2, plus any closures implemented in other fisheries, may adversely affect vessel safety causing vessels to travel farther and in potentially dangerous weather conditions. Therefore, significant beneficial or adverse cumulative effects on vessel safety are possible under PA.2.

4.9.9.1.3 Inshore Processors and Motherships

Direct/Indirect Effects of PA.1

Groundfish Landings By Species Group

A comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 inshore processor and mothership conditions reveals that under PA.1 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 50 percent. In addition, an increase in the TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant increase in the harvests of these species. Harvests of pollock and flatfish are not expected to change significantly.

Groundfish Gross Product Value

The wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to Bering Sea pollock shore plants, Alaska Peninsula, and Aleutian Islands shore plants, Kodiak shore plants, and floating inshore processors account for much of the increase in groundfish product value. Southeast Alaska shore plants and southcentral Alaska shore plants are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under PA.1, but not significantly.

Product Quality and Product Utilization Rate

As with catcher processors, a conditionally significant increase in product quality and product utilization rates is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the increase in product quality and utilization is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. With additional fisheries operating under rights-based management rather than the race for fish, inshore processors will likely be able to slow their overall throughput and focus on obtaining the highest value per fish rather than the most fish per unit of time.

Excess Capacity

A conditionally significant decrease in excess capacity in the harvesting and processing sectors is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in excess capacity depends on the extent to which PA.1 extends rights-based management to additional groundfish fisheries. In contrast to the harvesting sector; however, rights-based management measures can increase the excess capacity of inshore processors in the short run. For example, when the IFQ program was established for the sablefish and halibut longline fisheries additional fresh-market processors and buyers entered the fisheries. In addition, existing processors that had increased capacity to cope with the fish gluts that occurred under race for fish found that they had more capacity than was necessary under the slower-paced IFQ fisheries. In contrast, in the BSAI pollock fishery under the AFA, processing capacity increases were specifically limited by restricting entry into the pollock fishery and sideboard restrictions imposed on AFA catcher vessels. In the long-run; however, excess processing capacity is expected to significantly diminish in rationalized fisheries.

Average Costs

As with catcher vessels, a conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in average costs depends on the extent to which PA.1 extends rights-based management to additional groundfish fisheries.

Increased rationalization is expected to reduce the costs of processing. Individual processing facilities will have the opportunity to select the least cost combination of processing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective processing operations. Fixed costs will be reduced by consolidating processing operations and retiring or selling-off processing equipment. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting and processing rights and on the level of excess capacity prior to implementation of remedial measures.

For a summary of the direct/indirect effects on inshore processors and motherships under PA.1 (Table 4.9-6).

Cumulative Effects of PA.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on inshore processors and motherships are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Overall, retained harvests of groundfish species are expected to be insignificant except for Pacific cod, which are expected to have significant effects.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.

- **Cumulative Effects**. Inshore plants and motherships that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. Those that process halibut may be less sensitive to these reductions in other fisheries. The combination of increases in halibut, reductions in salmon and crab and relatively stable projections (except for significant increases in Pacific cod) for groundfish, may result in insignificant cumulative effects under PA.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate changes may result in potential increases or decreases in fish populations (see Section 4.9.1), these changes are not expected to result in significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects**. The gross product value is expected to increase, but not significantly from the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (7 percent) that are predicted for PA.1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from PA.1.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Employment and payments to labor are expected to increase but not significantly under PA.1.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Processors that rely on salmon and crab may continue to experience reductions in employment and payments to labor. Groundfish employment and labor income projections under PA.1 are not significant (7 percent) but may mitigate some of the reductions due to salmon and crab. Processors may experience increases if they process halibut and groundfish due to recent increases in the halibut fishery. The combination of reductions and increases in these multiple fisheries are likely to result in insignificant cumulative effects on employment and payments to labor are expected under PA.1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. A conditionally significant increase in product quality and utilization rate are expected under PA.1 relative to the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As with catcher processors, advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has made significant differences in product quality and utilization; however, any continuation of this harvest strategy in fisheries may hinder some of these improvements. Overall, increases in product quality and utilization are likely in the long-term given the trend towards improved fishing and preservation techniques. Thus, conditionally significant beneficial cumulative effects are projected under PA.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. A conditionally significant beneficial effect in excess capacity is expected under PA.1 relative to the baseline. Capacity is expected to decrease.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (see Appendix F-8). Should rights-based management extend to additional groundfish fisheries, excess capacity would be further reduced. Therefore, a conditionally significant beneficial cumulative effect is expected to occur for excess capacity under this FMP, particularly if other fisheries do not change their licensing programs.

Average Costs

- **Direct/Indirect Effects**. A conditionally significant beneficial effect in average costs are expected under PA.1 relative to the comparative baseline. Average costs are expected to decrease.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described under catcher vessels and catcher processors, average costs in the groundfish fisheries are often associated or shared with other fisheries and include both fixed and variable costs. Vessels that are dependent on multiple fisheries are often sensitive to changes in costs in other fisheries. As rights-based management may be extended to other fisheries under PA.1, a conditionally significant beneficial cumulative effect on average costs in the groundfish fisheries is expected.

Direct/Indirect Effects of PA.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 inshore processor and mothership conditions reveals that under PA.2 there would be a number of significant changes in overall harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 44 percent. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the harvests of these species. Harvests of pollock and flatfish are not expected to change significantly. Bycatch of non-target species and PSC is expected to decrease with incentives included in rationalization programs.

Groundfish Gross Product Value

The overall wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to short plants in the Bering Sea (pollock), Alaska Peninsula, Aleutian Islands, Kodiak, and floating inshore processors account for much of the increase in groundfish product value. Decreased deliveries of rockfish and sablefish will have a significant adverse impact on the product value of shore plants southeast and southcentral Alaska. The product value of shore plants in the Alaska Peninsula, the Aleutian Islands, and Kodiak will be adversely affected by this decrease, but less so.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under PA.2, but not significantly.

Product Quality and Product Utilization Rate

As with catcher processors, a significant improvement or a conditionally significant reduction in product quality and utilization rates could occur under PA.2 relative to the comparative baseline. The net effect of the various measures on product quality and utilization is uncertain. The implementation of a comprehensive rights-based management program will tend to improve product quality and utilization rates. However, a large portion of the product currently produced by inshore processors and motherships is already produced in rationalized fisheries (e.g., sablefish longline fishery and BSAI pollock fishery). Furthermore, the additional area closures considered under PA.2 may cause product quality to decrease. Pacific cod and Alaska pollock are fragile fish whose quality deteriorates rapidly the longer the time from harvest to processing. As such, any factors that will increase the length of time to processing will, in general, lower the quality of the product produced. To the extent that PA.2 results in catcher vessels traveling farther distances from (inshore) processors, and thereby lengthening the time between harvest and processing, the quality of surimi, fillets, and roe will be adversely affected.

Excess Capacity

As with catcher vessels and catcher processors, the comprehensive rationalization program that would be implemented under PA.2 is expected to result in a significant decrease in excess capacity in the processing sectors relative to the comparative baseline in the long-term. In the short-term, however, a comprehensive rationalization may create excess capacity that would continue during the transition from the race for fish to rights-based management.

Average Costs

The net effect of PA.2 on average costs relative to the baseline is uncertain. If implemented, the area closures to protect habitat are likely to contribute to higher average costs for processors. On the other hand, a comprehensive rationalization program is expected to contribute to lower average costs. This leads to conditionally significant adverse and significant beneficial direct/indirect effects ratings for average costs under PA.2.

Although it is uncertain to what extent PA.2 would establish additional area closures to protect habitat, this FMP could include measures that result in considerable spatial displacement of fishing effort. The result could be substantial increases in average costs. However, an expanded rationalization program is expected to reduce the costs of processing. Individual processing facilities will have the opportunity to select the least cost combination of processing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective processing operations. Fixed costs will be reduced by consolidating processing operations and retiring or selling off processing equipment. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting and processing rights and on the level of excess capacity prior to implementation of remedial measures.

Cumulative Effects of PA.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Projected increases in Pacific cod are expected under PA.2; however, sablefish and rockfish will decrease significantly. Pollock and flatfish harvests are not expected to change significantly.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects**. Current downward trends in the commercial salmon and crab fisheries may put pressure on processors who do not rely on mixed harvests. Those processors that rely on groundfish and halibut catch may experience some increases in landings under PA.2. The significant increases in Pacific cod and the current increasing trends in halibut may counteract the reductions in other fisheries. Insignificant cumulative effects on groundfish landings are expected to result under PA.2. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations as explained in more detail in Section 4.9.1, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

<u>Groundfish Gross Product Value</u>

- **Direct/Indirect Effects**. The gross product value is expected to increase from the baseline, but not significantly. Decreased deliveries of rockfish and sablefish will have a significant adverse impact on the product value of shore plants in southeast and southcentral Alaska. The product value of shore plants in the Alaska Peninsula, Aleutian Islands, and Kodiak will be adversely affected by this decrease but less so than southeast and southcentral Alaska.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described with catcher processors, changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (4 percent) that are predicted for PA.2 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from PA.2.

<u>Employment and Payments to Labor</u>

- **Direct/Indirect Effects**. Insignificant effects are predicted for catcher processors under PA.2.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of the groundfish and halibut fisheries. The increase, although slight, in groundfish employment (5 percent) under PA.2 is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are projected to increase slightly (4 percent) under PA.2, thereby mitigating some of the reductions in other fisheries. Changes in other fisheries are not expected to contribute to cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under PA.2.

<u>Product Quality and Product Utilization Rate</u>

- **Direct/Indirect Effects**. A significant improvement or a conditionally significant reduction in product quality and utilization rates could occur under PA.2 relative to the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Technological advances have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has made significant differences in product quality and utilization; however, the possible increase in area closures may counteract any improvements in product quality achieved by better handling. Overall, increases in product quality and utilization are likely in the long-term given the trend towards improved fishing and preservation techniques. Thus, significant beneficial or adverse cumulative effects are possible under PA.2.

<u>Impacts on Excess Capacity</u>

- **Direct/Indirect Effects.** Significantly beneficial changes in excess capacity are possible under PA.2 relative to the baseline. The net effect of these measures on capacity is unknown (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Although excess capacity still remains in other fisheries as well as the groundfish fishery, comprehensive rationalization and an end to the race for fish help mitigate this effect (see Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under PA.2, the cumulative effects on excess capacity are likely to be significantly beneficial compared the baseline.

Average Costs

- **Direct/Indirect Effects**. Both significantly beneficial and conditionally significant adverse effects are possible under this FMP. If implemented, spatial closures to protect habitat are likely to increase costs; however, comprehensive rationalization would decrease costs.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described for catcher vessels and catcher processors, average costs in the groundfish fisheries are often associated or shared with other fisheries and include fixed and variable costs. Increases in closure areas increase costs whereas decreases in closures usually decrease costs. The cumulative effect on average costs under PA.2 is uncertain because it is unknown to what extent the FMP would create MPAs and no-take reserves to protect habitat. Furthermore, any cost increases that occur as a result of implementation of area closures could be offset to some extent by the cost reductions that are expected to occur as a result of comprehensive rationalization of the groundfish fisheries (see the direct/indirect effects discussion in this section). Significant beneficial or adverse cumulative effects are possible under PA.2.

4.9.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described below (Table 4.9-6). The past/present effects on regions that participate in the groundfish fishery are described in Section 3.9 (and summarized in Table 3.9-126) and below. These regions (illustrated in Figures 3.9-9 through 3.9-14) include the Aleutian Islands/Alaska Peninsula (comprised of the Aleutians East Borough and the Aleutians West Census Area, which includes the communities of Unalaska, Nikolski, Atka, Adak and the Pribilof Islands), Kodiak Island (Kodiak Island Borough, which includes the City of Kodiak) southcentral Alaska (the Kenai Peninsula Borough, Matanuska-Susitna Borough, Municipality of Anchorage (which includes the cities of Eagle River, Chugiak, and Girdwood), the Valdez-Cordova Census Area (which includes the PWS region), southeast Alaska (all of the southeastern part of the state, from Yakutat Borough to Dixon Entrance), Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca), and the Oregon coast (Lincoln, Tillamook, and Clatsop counties, the three northernmost Oregon coastal counties). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case.

Due to the linkages of potential effects on regions that participate in the groundfish fishery to changes in harvest and processing levels under each of the policy alternatives and illustrative bookends, the direct and indirect effects of each alternative are based on an economic model that distributes potential effects to each of the participating regions. The indicators used to assess potential regional effects include the following:

- In-region Processing and Related Effects.

- Regionally Owned At-Sea Processors.

- Extra-regional Deliveries of Regionally Owned Catcher Vessels.

- In-region Deliveries of Regionally Owned Catcher Vessels.

- Total Direct, Indirect, and Induced Labor Income and full-time equivalents (FTEs).

As discussed earlier, these indicators reflect changes in other important regional characteristics such as secondary economic activity associated with the support of fishing, state and municipal revenue generated by fishing, and indirectly population, to the extent that it is related to employment opportunities (see Section 4.1.7).

Direct/Indirect Effects of PA.1

Under PA.1, in general there is a net overall increase in fishery socioeconomic indicator values over baseline conditions for all regions. For example, total value of processing sales increases over baseline conditions, while total processing and harvesting related income and employment increase for all regions combined. These changes typically do not rise to the level of significance. Overall, the pattern of change is driven by the same factors seen under FMP 1 (but the caveat of inaccurate distribution indicator values associated the A-R-S-O species group between the southcentral and southeast Alaska regions applies). The following subsections provide a region-by-region summary of change under PA.1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under PA.1, total in-region groundfish processing value would increase (with increases occurring in the BSAI values), as would in region processing associated labor income and FTE jobs, but none of these increases would be considered significant. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would increase in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease, but by a less than significant amount. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would decrease for in-region deliveries, catcher vessel payments to labor. FTEs would decrease, but all of these changes are less than significant, and for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes. The total regional direct, indirect, and induced labor income, and FTE employment would increase under this alternative, but this increase would not be significant. Under Alternative PA.1, the more closely sector defined impacts may be considered less than significant on a local sector as well as a regional and most likely a multiple community basis. However, this alternative may result in a number of other types of impacts that could be significant under certain conditions.

Under PA.1 some structural changes in the fishery and support sector enterprises will accrue to this and other regions as a result of the rights-based and community based management, but in the absence of program specifications, it is not possible to identify those changes in a straightforward manner. In general, with a decline in the race for fish, consolidation is likely to occur within processing and harvesting sectors and across communities. However, rights-based programs may build in caps and/or community or regional protection measures to act as a governor on consolidation, and the impacts to particular communities or regions will depend on the nature and efficacy of those caps or restrictions. Also, in general terms, the number of processing and harvesting entities will decline, as will overall employment. Support sector businesses and some coastal communities that have large support sectors deriving benefits from seasonal peaks and the economic inefficiencies of current race-for-fish fisheries will experience adverse impacts, at least in the short-term during a transition to a lower, if more stable level of employment, and in general, higher labor income per remaining position. For example, the relatively well developed support service sector in Unalaska/Dutch Harbor derives marked benefits from the current economic inefficiency within the fishery. It is relatively expensive to provide services in the community, but under conditions where it is important to minimize down-time during a fishing season, services that cost more are often utilized. Under a rationalized fishery, cost considerations become relatively more important, giving service purchasers more options to the possible detriment of providers in relatively remote locations. These types of impacts will perhaps be most apparent or severe in this region due to a relative lack of diversification in local economies, although they will likely be seen in other regions as well, especially Kodiak. The economic modeling that generated the regional impact numbers accounted for the structural changes in the fishery, but did not account for potential community protection measures. As a result, impacts may be considered conditionally significant adverse, and dependent upon the specific yet-to-be-designed protection measures.

Kodiak Island. Total in-region groundfish processing value would increase, with higher values for GOA and BSAI values are not a significant portion of the regional total. Associated labor income and FTE jobs would increase, but none of these increases would be large enough to be significant. Regionally owned at-sea processing value would increase with the majority of the increase attributable to changes in the BSAI values. Associated labor income and FTEs would increase, and the increase in total value would be significant. In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales, and regionally owned at-sea processing accounts for about one-quarter of the total. Labor income and FTEs distribution between these processing sectors follow a similar pattern. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase, as would catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries, but these increases would not be significant. For in-region deliveries, catcher vessel payments to labor would increase and FTEs would decrease, but these changes would be less than significant and over a smaller base than seen for extra-regional deliveries. On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was observed in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would increase, as would FTE employment under this alternative, but none of these changes would be considered significant. For the Kodiak Island region, Alternative PA.1 would not result in significant impacts on a local sector basis, or on a regional or community basis. As noted under the Alaska Peninsula and Aleutian Islands region discussion, there could be some adverse impacts to Kodiak Island region support services due to changes associated with the rationalization of the fishery, but Kodiak could also be the beneficiary of service business displaced from more remote locations, so the net impact is unknown.

Southcentral Alaska. Total in-region groundfish processing value would increase by 36 percent (all are attributable to GOA increases), as would associated labor income and FTE jobs. Regionally owned at-sea processing value would increase by 28 percent with relatively large increases in the BSAI values and smaller increases in the GOA values. Associated labor income and FTEs would each also increase by 28 percent. In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales, and regionally owned at-sea processing accounts for about one-fifth of the total. Labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector. The value of extra-regional deliveries by regionally owned catcher vessels would increase, but by an insignificant amount, while in-region deliveries would increase by 44 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would each also increase by about 44 percent. In this region, catcher vessel-associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 28 percent, and FTE employment would increase by 21 percent. For the southcentral Alaska region, Alternative PA.1 would have significantly beneficial impacts on a local sector basis, but it is important to recognize that some of these changes may be overstated and some understated for the southeast Alaska region. Impacts to the region as a whole and participating communities may be less significant than would otherwise appear to be the case, given the diversified nature of the local economies and the relative lack of dependence on groundfish related activities.

Southeast Alaska. Total in-region groundfish processing value would decrease by a negligible amount; all are attributable to GOA decreases. Associated labor income and FTE jobs would decrease but both have relatively low base values. Regionally owned at-sea processing value would increase by 25 percent with increases in both BSAI and GOA values, and associated labor income and FTEs would each also increase by 25 percent. In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales, and regionally owned at-sea processing accounts for about three-tenths of the total. Labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector. The value of extra-regional deliveries by regionally owned catcher vessels would increase by a slightly less than significant amount, and in-region deliveries would decrease by a negligible amount. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase and in-region deliveries, catcher vessel payments to labor and FTEs would remain about the same. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase as would FTE employment, but these changes would be less than significant. The impacts from Alternative PA.1 is significant beneficial for some local sectors, but impacts on a regional basis for southeast Alaska are less than significant, and are likely to be so for the involved communities, given the local economic diversity and relatively light dependence on the groundfish fishery.

Washington Inland Waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small fluctuations in the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase with increases in both BSAI and GOA values, although GOA values are comparatively small. Associated labor income and FTEs would both increase, but these changes would be less than significant. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase, as would catcher vessel payments to labor and FTE jobs associated with extra regional deliveries, and those associated with in-region deliveries. However, none of these changes would rise to the level of significance. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase as would FTE jobs, but these changes would not be significant. Alternative PA.1 would have consistently beneficial effects in the Washington inland waters region, but these gains would not rise to the level of significance on a local sector, regional, or community basis.

Oregon Coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this alternative. Similarly, there are currently no regionally owned at-sea processors under baseline conditions and none foreseen under this alternative, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but these increases would not be significant. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this alternative. The total regional direct, indirect, and induced labor income would increase, as would FTE employment, but these changes would not be significant. Alternative PA.1 would have consistently beneficial impacts for the Oregon coast region, but these would not rise to a level of significance for local sectors, the region, or individual communities.

Cumulative Effects of PA.1

See Table 4.9-6 for a summary of the cumulative effects on regions and communities under PA.1.

<u>In-Region Processing and Related Effects</u>

- **Direct/Indirect Effects**. For PA.1, direct/indirect effects are considered insignificant for most regions except the southcentral Alaska region where a significantly beneficial increase is expected to occur.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, Alternative 1, Section 4.5.9.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts (see Section 4.5.9).

- **Cumulative Effects.** Under PA.1, cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant, although for different reasons in different regions. The influence of external factors is adverse for many of the in-region processors based in Alaska and their associated regions. Trends in multi-species fisheries and other sources of municipal and state revenue, primarily due to the continued crab closures, downturn in salmon and reductions in state and municipal revenue result in adverse effects on in-region processing and municipal revenue. These adverse external effects are somewhat offset by increases in Alaska in-region processing, resulting in a finding of insignificant cumulative effect except in portions of the Alaska Peninsula/Aleutian Islands Region. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution, resulting in a finding of insignificant cumulative effect.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects**. Under PA.1, direct/indirect effects are considered significantly beneficial for Kodiak Island, southcentral Alaska, and southeast Alaska regions. Direct/indirect effects are generally insignificant for the Alaska Peninsula/Aleutian, Washington inland waters, and Oregon coast regions.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue (see Section 4.5.9).

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts (see Section 4.5.9).

- **Cumulative Effects**. Under PA.1, cumulative effects on regionally owned at-sea processing and on related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. While direct/indirect effects are beneficial for Kodiak Island, southcentral Alaska, and southeast Alaska, the size and diversity of the southcentral Alaska regional economy, and offsetting adverse external factors related to other fisheries result in insignificant cumulative effects. Direct/indirect effects are insignificant in the Alaska Peninsula/Aleutian Islands, Washington inland waters, and Oregon coast regions. As indicated previously, with a more diversified economy and population base, cumulative effects on the at-sea processors in Kodiak will be insignificant for the Washington inland waters, and Oregon coast regions, as are effects for the Alaska Peninsula/Aleutian Islands.

Extra-regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects**. Under PA.1, direct and indirect effects are insignificant for all regions.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut (see Section 4.5.9).

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects**. Under PA.1, extra-regional deliveries increase and direct/indirect effects are insignificant for all six regions. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. Extra-regional deliveries decrease to the Alaska Peninsula/Aleutian Islands; adverse external effects related to other fisheries and revenue sharing results in a conditionally significant adverse cumulative effect for some communities within this region.

<u>In-Region Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects**. Under PA.1, direct/indirect effects are insignificant with slight increases or decreases for all regions except southcentral Alaska, where the increase is significantly beneficial.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects**. Under PA.1, the direct/indirect effects range from beneficial to mostly insignificant. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. Extra-regional deliveries decrease to the Alaska Peninsula/Aleutian Islands; adverse external effects related to other fisheries and revenue sharing results in a conditionally significant adverse cumulative effect for some communities within this region.

<u>Total Direct, Indirect, and Induced Labor Income and FTE's</u>

- **Direct/Indirect Effects**. Under PA.1, direct/indirect effects on labor income and employment are significantly beneficial for the southcentral Alaska region, and insignificant for the rest of the regions.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects**. Under PA.1 direct/indirect effects on labor income and employment are insignificant for all regions, except southcentral Alaska, which is significantly beneficial. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Adverse trends in other fisheries (particularly salmon) and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are generally insignificant in all regions, except for portions of the Alaska Peninsula/Aleutian Islands, where effects are conditionally significant adverse.

Direct/Indirect Effects of PA.2

Under PA.2, in general, there is more variation of gains and losses in socioeconomic indicator values across regions than seen in the previous alternatives. While total value of processing sales increases over baseline conditions by a less than significant amount, and while total processing and harvesting related income and employment increase for all regions combined by a less than significant amount, there are a variety of increases and decreases behind these totals. A more conservative TAC for sablefish and rockfish has a disproportionate, adverse impact on the southcentral and southeast Alaska regions, and on the Kodiak region. The western GOA area experiences a relative decline of Pacific cod related values. On the highest level of aggregation, the Alaska Peninsula and Aleutian Islands, Washington inland waters, and Oregon coast regions experience a net beneficial impact under Alternative PA.2, whereas the Kodiak, southcentral, and southeast Alaska regions experience a net adverse impact in socioeconomic terms. Under this alternative there are many local area closures and it is to be expected (but not apparent in the data) that the smaller catcher vessels with less effective range and less inherent geographic flexibility would feel disproportionate impacts in all regions. The rationalization that occurs under this alternative would likely serve to ameliorate the adverse impacts of area closures for most of the fleet, but inherent limitations associated with size would render these offsetting benefits less viable for the small vessels of the fleet. For all vessels, the beneficial impacts of rationalization are conditional on being able to find fish outside of the closed areas. These pragmatic challenges may push adverse impacts from borderline to significant for some communities, depending the composition of the local fleet, particularly in the southcentral and southeast Alaska regions. The following subsections provide a region-by-region summary of change under Alternative PA.2 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under Alternative PA.2, total in-region groundfish processing value would increase, with increases in the BSAI portion somewhat offset by decreases in the much smaller GOA portion of the total. Regional processing associated labor income and FTE jobs would increase as well, but these increases would be insignificant. Regionally owned at-sea processing value and associated payments to labor and FTEs would increase in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional deliveries by regionally owned catcher vessels would decrease by 17 percent, while in-region deliveries by regionally owned catcher vessels would decrease by 22 percent. Catcher vessel payments to labor would decrease 17 percent and FTE jobs associated with extra-regional deliveries would decrease by about 23 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 22 and 23 percent, respectively, but for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes. The total regional direct, indirect, and induced labor income would increase as would FTE employment, but these changes would be less than significant. In terms of quantitative output, the impacts of Alternative PA.2 on the Alaska Peninsula and Aleutian Islands region are a mixture of adverse and beneficial when examined on a local sector basis, but are in and of themselves not likely to illustrate significant impacts on the regional level. Community level quantitative data are largely unavailable due to confidentiality restrictions. There are two other types of regional or community impacts likely under this alternative that are not apparent in the quantitative data.

In general, as noted under PA.1, with a decline in the race for fish, consolidation is likely to occur within processing and harvesting sectors and across communities. However, rights based programs can include caps and/or community or regional protection measures to act as a governor on consolidation, and the impacts to particular communities or regions will depend on the efficacy of those caps or restrictions. Also in general terms, the number of processing and harvesting entities will decline, as will overall employment. Support sector businesses and some coastal communities that have large support sectors, that derive benefits from seasonal peaks and the economic inefficiencies of current race-for-fish fisheries will experience adverse impacts, at least in the short-term during a transition to a lower if more stable level of employment and, in general, higher labor income per remaining position. These types of impacts will be seen in other regions as well, especially Kodiak, but will perhaps be most apparent in this region due to a relative lack of diversification in local economies. The economic modeling that generated the regional impact numbers accounted for the structural changes in the fishery, but does not account for potential community protection measures. As a result, impacts may be considered conditionally significant, and dependent upon the future protection measures.

Another type of impact that is not captured by the economic output model is likely to be important for some communities in the Alaska Peninsula and Aleutian Islands region. Under PA.2, more areas are set aside for MPAs, and the impact of these on communities, especially communities with relatively small vessel fleets with limited range and flexibility to move between major fisheries, may be relatively large. However, the ultimate determinant of the level of impact of this type of management approach will be the efficacy of the counterbalancing alternative features designed to respect traditional fishing grounds and maintain open area access for coastal communities. It is not possible to assess this balance in advance of having either the MPA areas or the community protection measures specified. As a result, impacts of this nature are likely to be conditionally significant. The small vessel fleets within this region are particularly vulnerable. Further, communities within this region that have both support service sectors that may experience decline as a result of rationalization and small vessel fleets may experience interactive impacts that are not apparent from quantitative modeling outputs.

Kodiak Island. Total in-region groundfish processing value would decrease and associated labor income and FTE jobs would decrease, but none of these changes would be significant. Regionally owned at-sea processing value would increase with the vast majority of the increase attributable to changes in the BSAI values. Associated labor income and FTEs would increase, but none of these changes would rise to the level of significance. In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total. Labor income and FTE distribution between these processing sectors follow a similar pattern. The value of extra-regional deliveries by regionally owned catcher vessels would increase as would catcher vessel payments to labor associated with extra-regional deliveries, but all of these changes would be less than significant, and FTE jobs would remain about the same. For in-region deliveries, the total value would remain generally the same while catcher vessel payments to labor and FTEs would decrease by insignificant amount, and over a smaller base than seen for extra-regional deliveries. On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would decrease as would FTE employment, but all of these changes would be minimal. For the Kodiak Island region, Alternative PA.2 will have less than significant impacts on a local sector basis, as well as on a regional and community of Kodiak basis. As was the case for the Alaska Peninsula and Aleutian Islands region, there may be conditionally significant impacts that accrue to the support service sector as a result of the rationalization features of this alternative and the smaller vessels in the fleet due to the inherent lack of flexibility in dealing with extensive MPA set asides and, perhaps, the inability to take advantage of the potentially ameliorating nature or features of rationalization.

Southcentral Alaska. Total in-region groundfish processing value would decrease with all being attributable to GOA decreases. Associated labor income and FTE jobs would decrease, but these decreases would not be considered significant. Regionally owned at-sea processing value would decrease with decreases in the BSAI values and GOA values. Associated labor income and FTEs would decrease, but these changes would be less than significant. In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector. The value of extra-regional deliveries by regionally owned catcher vessels would decrease and in-region deliveries increase, but not significantly. Catcher vessel payments to labor would decrease a less than significant amount and FTE jobs associated with extra regional deliveries would decrease by about 19 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would increase, but not significantly. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease as would FTE employment, but none of these changes would appear significant. For southcentral Alaska, PA.2 would not result in significant impacts at either the local sector or the regional level. However, there may be conditionally significant impacts to some community small vessel fleets, but that cannot be ascertained prior to the development of specific features of the rationalization and MPA management approaches.

Southeast Alaska. Total in-region groundfish processing value would decrease by 33 percent and is attributable to GOA decreases. Associated labor income and FTE jobs would also decrease by 33 percent, but both are relatively low values. Regionally owned at-sea processing value would increase, with increases in both BSAI values and GOA values. Associated labor income and FTEs would decrease, but none of these changes are significant. In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total. Labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease by 24 and 35 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would both decrease by about 24 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 35 and 34 percent, respectively. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease by about 22 percent and FTE employment would decrease by about 22 percent. For the southeast Alaska region, Alternative PA.2 would have significant impacts on some local sectors, but a caveat on this data is that impacts to the southcentral Alaska region may be somewhat overstated in a beneficial direction, and the impacts to southeast Alaska may be somewhat overstated in a adverse direction. Overall, impacts on the regional level or even on the involved community level are unlikely to be significant given the overall diversity of community economies in this region, and the relative lack of dependency specifically on groundfish. On the other hand, there could be conditionally significant impacts that accrue to the local small vessel fleet as a result of specific rationalization and MPA features that are unknown at this time, as noted in earlier regional sections.

Washington Inland Waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes insignificant. Regionally owned at-sea processing value would increase with increases in both BSAI and GOA values, although GOA values are comparatively very small. Associated labor income and FTEs would decrease, but these increases would be less than significant. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by less than significant amounts. Catcher vessel payments to labor associated with extra regional deliveries would increase and FTE jobs would decrease, but these changes would not be significant. For in-region deliveries, catcher vessel payments to labor and FTEs would increase, but not significantly. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase, but these changes would be less than significant. The total regional direct, indirect, and induced FTE employment would decrease slightly, but not significantly. In general, the impacts of Alternative PA.2 would not be significant for the Washington inland waters region. Impacts to local sectors are likely to be less than significant, and as are impacts to communities, given the size and nature of local economies, and the relative lack of groundfish dependency on the community or regional level. The concerns regarding small vessel fleets and MPAs under this alternative do not apply to the Washington inland waters region in the same way that they do to the Alaska regions, nor do concerns regarding unintentional consequences of rationalization on support sector businesses. Washington inland waters region support sector enterprises are likely to be the beneficiaries of increased efficiency within the fishery, and a reallocation or redistribution of support functions away from remote locations closer to the grounds.

Oregon Coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this alternative. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this alternative, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but these increases would not be significant. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this alternative. The total regional direct, indirect, and induced labor income would increase as would FTE employment, but these changes would be considered less than significant. Under PA.2, Oregon coast local sectors would experience beneficial but less than significant impacts. Regional and community impacts would be considered beneficial, but less than significant. This region would not experience adverse impacts to the small vessel fleet from MPAs and rationalization as may be seen in the Alaska regions, nor is it likely to lose or gain significantly in the changes in support sector businesses that may accompany further rationalization of the fishery.

Cumulative Effects of PA.2

In-Region Processing and Related Effects

- **Direct/Indirect Effects.** For PA.2, direct/indirect effects are considered insignificant for all regions except the southeast Alaska region, which would see a significantly adverse decrease.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, Alternative 1, Section 4.5.9.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts (see Section 4.5.9).

- **Cumulative Effects.** Under PA.2, in terms of direct/indirect impacts, the Alaska Peninsula and Aleutian Islands, Washington inland waters, and Oregon coast regions experience a net beneficial impact, whereas the Kodiak Island, southcentral, and southeast Alaska regions experience a net adverse impact. Within these latter three Alaska regions, decreases in processing values are exacerbated by the adverse external effects in other fisheries, economic development and state and municipal revenue. Southcentral Alaska has a relatively diversified economy and cumulative effects would be insignificant. Cumulative effects for Kodiak Island, southeast Alaska and portions of the Alaska Peninsula and Aleutian Islands are likely to be conditionally significant adverse. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant and there are no reasonably foreseeable events that would have a significant contribution; the cumulative effects on these regions are therefore insignificant.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** For PA.2, direct/indirect effects are insignificant for all regions (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue (see Section 4.5.9).

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts (see Section 4.5.9).

- **Cumulative Effects.** Under PA.2, direct/indirect effects are insignificant for all six regions. Cumulative effects are also insignificant for PA.2, for the same reasons discussed under PA.1.

<u>Extra-regional Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects.** Under PA.2, direct and indirect effects are insignificant for all regions, except Alaska Peninsula/Aleutian Islands and southeast Alaska regions where they are significantly adverse (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut (see Section 4.5.9).

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects.** Under PA.2, cumulative effects are insignificant for four of the six regions, but adverse for Alaska Peninsula/Aleutian Islands and southeast Alaska regions. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. In southeast Alaska and the Alaska Peninsula/Aleutian Islands, adverse external effects are likely to result in conditionally significant adverse cumulative effects.

<u>In-Region Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects.** Under PA.2, direct/indirect effects are insignificant for the Kodiak Island, southcentral Alaska, Washington inland waters, and Oregon coast regions. Effects are significantly adverse for the Alaska Peninsula/Aleutian Islands and southeast Alaska regions. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects.** Under PA.2, direct/indirect effects of in-region deliveries range from mostly insignificant to significantly adverse. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. In the Alaska Peninsula/Aleutian Islands and southeast Alaska regions, significant adverse direct/indirect effects combine with adverse external effects in other fisheries and revenue sharing to result in a conditionally significant adverse cumulative effect.

Total Direct, Indirect, and Induced Labor Income and FTE's

- **Direct/Indirect Effects.** Under PA.2, direct/indirect effects on labor income and employment are insignificant for all regions except southeast Alaska, which is significantly adverse. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects.** Under PA.2, employment decreases in all Alaska regions, but is insignificant except in southeast Alaska where effects are significantly adverse. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Adverse trends in other fisheries, particularly salmon, and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Islands, and southeast Alaska regions. Cumulative effects are generally insignificant in all regions, except for portions of the Alaska Peninsula/Aleutian Islands and southeast Alaska regions, where effects are conditionally significant adverse.

4.9.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under the PA.1 and PA.2 are described below (Table 4.9-6). The past/present effects on CDQ are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is allocation of catch to CDQ groups. It should be noted that allocation reflects potential revenue to CDQ groups, and indirectly the potential funds that are available for approved economic development activities in CDQ communities.

Direct/Indirect Effects of PA.1 and PA.2

Under PA.1, the CDQ program would continue to operate as it does under baseline conditions. Under PA.1, no adverse changes to the CDQ program or region in comparison to baseline conditions are foreseen.

Under PA.2, the CDQ program would continue to operate as it does under baseline conditions. Under PA.2, no adverse changes to the CDQ program or region in comparison to baseline conditions are foreseen. Refer to Table 4.9-6 for a summary of the direct/indirect effects on CDQ programs under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

CDQ Allocations

- **Direct/Indirect Effects**. The direct/indirect effects of both PA.1 and PA.2 would be insignificant.

- **Persistent Past Effects.** The past/present effects on the CDQ program for groundfish fisheries include establishment of the CDQ program; FMP amendments that further added or defined CDQ in 1992, 1995, 1996, and 1998; establishment of multi-species CDQ programs, and persistent limitations on economic development and associated employment activities. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, other economic development activities, other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects**. Under PA.1 and PA.2, a cumulative effect is identified for the CDQ program, and the effect is judged to be insignificant. With guaranteed CDQ shares through the CDQ program continuing to operate, no significantly adverse cumulative impacts to the CDQ program are expected.

4.9.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described below (Table 4.9-6). The past/present effects on subsistence are described in Section 3.9 and below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, sport and personal use, and long-term climate changes and regime shift.

Direct/Indirect Effects of PA.1 and PA.2

Potential impacts to subsistence fall into four main categories: subsistence use of groundfish, subsistence use of Steller sea lions, salmon bycatch issues, and indirect impacts on other subsistence activities, including loss of income that would otherwise be directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. Under this alternative, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. There is no indication that this alternative would have a adverse impact on Steller sea lion subsistence activities or take over baseline conditions. Salmon bycatch would likely be decreased under PA.1 and PA.2 due to a moderate reduction in PSC limits and rationalization incentives under PA.2, but available information does not suggest that such reductions, while presumably beneficial for salmon subsistence resource use, would result in significant increases in salmon returns to salmon subsistence fishery areas. Catcher vessel activity and labor income are anticipated to increase under this alternative; therefore, no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

Cumulative Effects of PA.1 and PA.2

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described above (Table 4.9-6). The past/present effects on subsistence are described in Section 3.9 (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. Representative indicators used in this analysis are the same as those used in the direct/indirect analysis and include subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon, and indirect impacts on other subsistence activities such as income and joint production opportunities.

<u>Subsistence Use of Groundfish</u>

- **Direct/Indirect Effects**. Under this alternative, no changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline subsistence groundfish fishing conditions.

- **Persistent Past Effects.** Foreign, JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects**. Other fisheries and long-term climate change have a potential to adversely contribute to subsistence use of the groundfish fisheries. Economic development and sport and personal use are not likely to adversely contribute to subsistence use of the groundfish fisheries. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.1 and PA.2, a cumulative effect is identified for subsistence use of groundfish, but is judged to be insignificant. The external impacts of other fisheries, other economic development activities, and sport and personal use of groundfish are not likely to contribute to significantly adverse cumulative effects on the groundfish fisheries. However, other state-managed fisheries could have adverse impacts to the subsistence use of groundfish due to direct competition for the same species, but are not considered to be significant. The long-term climate change could adversely effect groundfish stocks.

Subsistence Use of Steller Sea Lions

- **Direct/Indirect Effects**. There is no indication that this alternative would have an adverse impact on Steller sea lion subsistence activities or take over baseline conditions.

- **Persistent Past Effects**. The past/present effects on subsistence use of Steller sea lions include the following: a long-term decline in population of Steller sea lions due to a number of factors; a long-term decline in relative importance of marine mammals in local diets; commercial groundfish fishing taking prey species utilized by Steller sea lions; and Steller sea lion protection measures designed to assist in population recovery instituted in 2000. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, economic development, and long-term climate change have a potential to adversely contribute to Steller sea lion subsistence activities. Sport and personal use of groundfish is not likely to adversely contribute to subsistence use of Steller sea lions. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.1 and PA.2, while an adverse cumulative effect is identified for subsistence use of Steller sea lions, the effect is judged to be insignificant. However, the cumulative effects of take, the continuing endangered status, and long-term decline in abundance are likely having population-level effects, but not enough to have significant indirect impacts to subsistence. The external impacts of other fisheries, other economic development activities of subsistence use of Steller sea lions are not likely to contribute adversely to the groundfish fisheries, and cumulative effects are insignificant.

Subsistence Use of Western Alaskan Salmon and Bycatch in the Groundfish Fishery

- **Direct/Indirect Effects**. Salmon bycatch would likely be decreased due to a moderate reduction in PSC limits under PA.1 and significantly reduced under PA.2, but available information does not suggest that such reductions, while presumably beneficial for salmon subsistence resource use, would result in significant increases in salmon returns to salmon subsistence fishery areas.

- **Persistent Past Effects**. The past/present effects on subsistence use of salmon include the following: utilization for subsistence since pre-contact times; and Area M closures implemented to decrease intercept of salmon; these factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects**. Other fisheries, other economic development activities and long-term climate changes and regime shift could all adversely contribute to salmon subsistence activities. Sport and personal use is not likely to adversely contribute to salmon subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.1 and PA.2, a cumulative effect is identified for subsistence use of salmon, and is judged to be insignificant. There may be benefits to subsistence use from reduced bycatch in the groundfish fisheries. However, given the depressed stock status of salmon runs in western Alaska, adverse contributions from external factors, and the salmon bycatch in the BSAI and GOA, sustainability of depressed salmon stocks could be adversely impacted, but are considered insignificant.

Indirect Impacts on Other Subsistence Activities

- **Direct/Indirect Effects**. Under both PA.1 and PA.2, catcher vessel activity and labor income are anticipated to increase insignificantly; therefore, no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

- **Persistent Past Effects**. The past/present effects on the indirect impacts on other subsistence activities include joint production as a part of local groundfish and other commercial fishery development from the outset; income from fishing used for investment in subsistence is similar to use of income from other activities. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, other economic development activities, and long-term climate changes and regime shift could all adversely or beneficially contribute to indirect subsistence activities. Sport and personal use is not likely to adversely contribute to indirect impacts on other subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.1 and PA.2, a cumulative effect is identified for indirect subsistence use, and the effect is judged to be insignificant. Income catcher vessel activity, and joint production opportunities are not expected to be affected adversely. However, the external impacts of other fisheries, other economic development activities, and long-term climate changes and regime shift could potentially contribute adversely to the indirect subsistence use.

4.9.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described below. The past/present effects on environmental justice are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The external effects used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, other sources of municipal/state revenue, and long-term climate changes and regime shift.

Direct/Indirect Effects of PA.1

Potential impacts that drive environmental justice issues include employment/municipal revenue and taxes in communities with significant percentages of special populations (Alaska Native and minority processing workforce); revenue to Native owned catcher vessels; revenue to Native owned catcher processors; subsistence activities associated with groundfish, Steller sea lions, and salmon; and the loss of income from fishing that would be otherwise directed toward subsistence pursuits; and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. The regions that could experience potential impacts include the Alaska Peninsula and Aleutian Islands, Kodiak Island, southcentral Alaska, southeast Alaska, Washington inland waters, Oregon coast, the CDQ regions, and western Alaska communities that harvest salmon for subsistence purposes.

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 250 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $498 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities, and no associated environmental justice impacts would occur. In this region, the ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this alternative, the total value of catcher vessel operations would decrease as would corresponding labor income and employment; therefore, an apparent environmental justice impact would result. However, as described above, these apparent declines are likely to be attributable in large part to a shortcoming in the model regarding distribution of western GOA catch to Alaska Peninsula and Aleutian Islands region vessels. So the actual environmental justice impact is likely to be insignificant, given current data.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 12 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $83 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the City and the Kodiak Island Borough. Given local and regional demographics, this is not likely to be an environmental justice issue. Ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the City of Kodiak itself; therefore, the local fleet associated population is not likely to be predominantly Alaska Native or comprised of other identified minority populations. Under this alternative, the total value of catcher vessel operations would increase as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be relevant as an environmental justice issue.

Southcentral Alaska. As described in existing conditions, environmental justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and it is unlikely that environmental justice issues will be associated with any employment change. In general, under this alternative overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns. Similarly, processing value increases, but these changes are not relevant to environmental justice concerns.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall environmental justice concerns appear not to apply in this region. In general, under this alternative overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns.

Washington Inland Waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, environmental justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this alternative, at-sea processing labor income and FTEs both increase, so there are no environmental justice impacts associated with this change.

Oregon Coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under this alternative overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not linked to environmental justice concerns.

CDQ Region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve environmental justice concerns. Under this alternative, the structure of the CDQ program would not change from baseline conditions and, as noted above, no adverse impacts to the program are anticipated. Therefore, no environmental justice impacts are likely to occur.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations. In a few cases such as Steller sea lion subsistence, exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve environmental justice concerns. Effects from reduced by-catch of salmon and Steller sea lion subsistence activities are likely to beneficial, but insignificant. As described above, adverse impacts to subsistence activities are not foreseen under this alternative; therefore no associated environmental justice impacts are anticipated.

Cumulative Effects of PA.1

The predicted direct and indirect effects of the groundfish fishery under PA.1 are described above. The past/present effects on environmental justice are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case (Table 4.9-6). The representative indicator used in this analysis is the same as that used in the direct/indirect analysis.

- **Direct/Indirect Effects**. Under PA.1 bookend, direct/indirect impacts are generally insignificant. Reductions in catcher vessel activity in the Alaska Peninsula/Aleutian Islands and reduction in the processing workforce in several regions are adverse, but are not significant. There would be some beneficial, but insignificant effects on subsistence harvest of salmon and Steller sea lions. No changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline environmental justice issues.

- **Persistent Past Effects**. Persistent past effects include trends and developments in fisheries and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, other economic development activities, and long-term climate changes and regime shift have the potential to adversely or beneficially affect environmental justice issues. Other sources of municipal state revenue has the potential to adversely affect environmental justice issues. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects**. Under PA.1, insignificant cumulative effects are identified for environmental justice. The direct/indirect effects on income for subsistence pursuits, and participation and employment opportunities for Alaska Natives in the fishery are generally beneficial. Reductions in revenues to local communities in the Alaska Peninsula/Aleutian Islands, in conjunction with the external effects from the crab closures and downturn in the salmon industry, could potentially affect environmental justice issues, but not of a magnitude to be significant. Effects from reductions in bycatch of salmon and Steller sea lion subsistence activities are beneficial but insignificant. The effects on income and joint production activities related to subsistence in the Alaska Peninsula/Aleutian Islands region are adverse, but cumulatively insignificant.

Direct/Indirect Effects of PA.2

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 265 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $500 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities, therefore, no associated environmental justice impacts would occur. In this region, the ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this alternative, the total overall net value of catcher vessel operations would decrease. Similarly, the corresponding labor income and employment would also decrease. Therefore, an apparent environmental justice impact would result, but as discussed under other alternatives, this may, in part, be an artifact of the model. The impacts to the local fleets that are conditionally significant adverse, resulting from MPA and rationalization design features, could be an environmental justice issue in this region. There could be adverse impacts to Alaska Native communities with support service businesses, but those would be in the form of conditional impacts, depending on the ultimate design of the programs.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would decrease over baseline conditions by about 45 jobs, which may result in an environmental justice impact. Total in-region groundfish processing value would decrease from $81 million to $75 million. Decreased in-region processing value would correspond to reduced municipal revenue and taxes to the City and the Kodiak Island Borough, and but given local and regional demographics, this is not likely to be an environmental justice issue. Ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the associated population to the local fleet is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under this alternative, the total value of regionally-owned catcher vessel operations would decrease as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be an environmental justice issue.

Southcentral Alaska. As described in existing conditions, environmental justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish-related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and it is unlikely that environmental justice issues will be associated with any employment change. In general, under this alternative overall combined direct, indirect, induced labor income, and FTEs decrease, but this change is not linked to environmental justice concerns. Similarly, processing value decreases, as do catcher vessel associated values, but these changes are not tied to environmental justice concerns.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is predominantly Alaska Native compared to other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but overall environmental justice concerns appear not to apply in this region. In general, under this alternative overall combined direct, indirect, induced labor income, and FTEs decrease, but this change is not linked to environmental justice concerns. Similarly, processing value decreases as do analogous catcher vessel associated values, but this change is not associated with environmental justice concerns.

Washington Inland Waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, environmental justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this alternative, at-sea processing labor income and FTEs both increase, if not significantly, so there are no environmental justice impacts associated with this change.

Oregon Coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under this alternative overall combined direct, indirect, induced labor income, and FTEs increase, as do catcher vessel related values, but these changes are not linked to environmental justice concerns.

CDQ Region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve environmental justice concerns. Under this alternative, the structure of the CDQ program would not change from baseline conditions, and as noted above, no adverse impacts to the program are anticipated. Therefore, no environmental justice impacts are likely to occur.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations. A few cases, such as Steller sea lion subsistence activities, exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve environmental justice concerns. Effects from reduced bycatch of salmon and Steller sea lion subsistence activities are likely to be beneficial, but insignificant. As described above, adverse impacts to subsistence activities are not foreseen under this alternative, therefore no associated environmental justice impacts are anticipated.

Cumulative Effects of PA.2

The predicted direct and indirect effects of the groundfish fishery under PA.2 are described above. The past/present effects on environmental justice are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case (Table 4.9-6). The representative indicator used in this analysis is the same as the direct/indirect analysis.

- **Direct/Indirect Effects.** Under PA.2 direct/indirect impacts on environmental justice issues in the Alaska Peninsula/Aleutian Islands region are conditionally significant adverse. This is due to reductions in catcher vessel activity and associated effects on opportunities for Alaska Natives to participate in groundfish fisheries, and on income and joint production opportunities related to subsistence. There would be some beneficial, but insignificant effects on subsistence harvest of salmon and Steller sea lions.

- **Persistent Past Effects**. Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, other economic development activities, and long-term climate changes and regime shift have the potential to adversely or beneficially affect environmental justice issues. Other sources of municipal and state revenue have the potential to adversely affect environmental justice issues. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.2, direct/indirect effects related to environmental justice are generally insignificant for most regions. Beneficial effects are expected for subsistence harvests; however, conditionally significant adverse effects due to reductions in catcher vessel activity are expected in the Alaska Peninsula/Aleutian Islands. The external effects from the crab closures and downturn in the salmon industry and reductions in employment funded by public revenue, and reductions in revenue to Native communities are adverse, primarily in the Alaska Peninsula/Aleutian Islands, where cumulative effects are conditionally significant adverse for environmental justice issues. Effects from reduction bycatch of salmon and Steller sea lion subsistence activities are beneficial, but insignificant. Direct/indirect effects on income and joint production activities related to subsistence in the Alaska Peninsula/Aleutian Islands region are adverse but insignificant. Cumulative effects are conditionally significant adverse due to downturns in other fisheries and decreased income and opportunities for joint production.

4.9.9.6 Market Channels and Benefits to United States Consumers

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described below (Table 4.9-6). The past/present effects on market channels and benefits to U.S. consumers are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.9-6). The representative indicator used in this analysis is benefits to U.S. consumers.

Direct/Indirect Effects of PA.1 and PA.2

Neither PA.1 nor PA.2 are expected to have significant effects on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Under both PA.1 and PA.2, the BSAI and GOA groundfish fisheries are expected to continue to provide high and relatively stable levels of seafood products to domestic and foreign markets. An estimate of the final market value of BSAI and GOA seafood products is not available; however, it would be substantially greater than $1.5 billion, the projected five-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing under both PA.1 and PA.2. This wholesale product value mean is higher than the comparative baseline, but the increase is not significant.

The rationalization of groundfish fisheries occurring under PA.2 could increase consumer benefits by resulting in an increase in the quality of groundfish products available to consumers relative to the comparative baseline. Moreover, rationalization has the potential to increase the proportion of Alaska groundfish products that are purchased by U.S. consumers because there will be more incentive to create the fresh and value-added products that are popular in the domestic market. With current technology and tastes, the greatest gains for U.S. consumers are likely to result from a greater supply of fresh and value-added products from Pacific cod and rockfish. However, these species currently account for less than one-third of all Alaska groundfish production. Furthermore, it is unlikely that all Pacific cod and rockfish will be sold to U.S. consumers. Consequently, the increased benefits to U.S. seafood consumers are not expected to be significant.

Cumulative Effects of PA.1 and PA.2

See Table 4.9-6 for a summary of the cumulative effects on market channels under PA.1 and PA.2.

- **Direct/Indirect Effects**. Under this alternative, increases in benefits to U.S. consumers of groundfish products are expected to occur, but are insignificant.

- **Persistent Past Effects**. These effects on benefits to U.S. consumers of groundfish products include: Alaska Seafood Marketing Institute product promotion activities, research and public awareness regarding the health benefits of seafood consumption, aquaculture development increasing overall availability and demand for seafood products, competition from aquaculture products, and changes in processing technology increasing seafood quality.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable effects include other fisheries (supply of product) and long-term climate changes and regime shift. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects**. Under PA.1 and PA.2, a cumulative effect is identified for benefits to U.S. consumers of groundfish products, and the effect is judged to be insignificant. The external impacts of other fisheries have the potential to contribute adversely or beneficially to U.S. consumers of groundfish products and groundfish market channels. However, the wholesale groundfish product value in conjunction with products from other fisheries is not expected to change benefits to U.S. consumers. Long-term climate changes and regime shift could adversely effect availability for market channels due to natural fluctuations in groundfish stocks.

4.9.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (including Non-Consumptive and Non-Use Benefits)

The predicted direct and indirect effects of the groundfish fisheries under PA.1 and PA.2 on the level of benefits that marine ecosystems and associated species provide to the U.S. general public are described below (Table 4.9-6). This section will also assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are the benefits, including non-consumptive and non-use benefits, the public derives from the Bering Sea and GOA marine ecosystems and associated species.

Direct/Indirect Effects of PA.1 and PA.2

PA.1 is predicted to have no significant effects on the level of benefits the Bering Sea and GOA marine ecosystems and associated species provided relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of PA.1 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.9.10 of the draft Programmatic SEIS.

The Bering Sea and GOA marine ecosystems and species associated with them provide a broad range of benefits to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value that the public places on protecting ecological conditions, Section 3.9.7 provides a qualitative discussion of possible benefits provided by the Bering Sea and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people can not directly interact with the Bering Sea and GOA marine ecosystems and the various species associated with them, but derive satisfaction from knowing that the structure and function of these ecosystems are protected.

The focus of this analysis includes direct and indirect effects of the alternatives on ecosystem benefits other than those that accrue to members of society who make a living harvesting, processing, and distributing BSAI and GOA groundfish products or who purchase and consume these products. The direct and indirect effects of the alternatives on firms and communities that derive value from the commercial harvest and processing of groundfish are described elsewhere in the draft Programmatic SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of the draft Programmatic SEIS.

The non-monetary or social value that people assign to those marine ecosystem benefits that are unrelated to commercial groundfish fisheries are thought to be considerable. For example, the value of protecting the Steller sea lion alone could be substantial. As discussed in Section 3.9.7, a contingent valuation study suggests that there is a significant willingness to pay on the part of the American public for an expanded federal Steller sea lion recovery program. At this time, there is insufficient information to provide a comprehensive measure of the benefits derived from these ecosystems and the various species associated with them.

PA.1 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. These measures include a network of spatial and temporal closure areas that disperse fisheries geographically and seasonally, a prohibition on the use of non-pelagic trawl gear to fish for pollock in the BSAI, bycatch reduction measures such as the full retention requirement for Pacific cod and pollock, and measures to reduce the incidental catch of seabirds. Furthermore, as discussed in Section 4.7.11, PA.1 is not expected to result in a significant change in the quantitative measures of any indicators of fishing impacts on marine ecosystems relative to the baseline. Consequently, the change in the level of benefits these ecosystems provide is not expected to be significant.

PA.2 is predicted to lead to a conditionally significant increase in the level of benefits the Bering Sea and GOA marine ecosystems and associated species provide relative to the comparative baseline. The significance of the increase in benefits is conditional because it is uncertain to what extent PA.2 would close additional areas as MPAs or no-take reserves. These findings are based on the assessment of the direct and indirect effects of PA.2 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.7.11 of the draft Programmatic SEIS.

PA.2 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. In addition, under PA.2 the establishment of additional area closures is considered. If implemented, these closures would close off up to 20 percent of the EEZ as MPAs and no-take marine reserves across a full range of marine habitats within the 1000 m bathymetric line (see Figure 4.2-5). The closures would aim to provide protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species.

Furthermore, PA.2 would undertake a comprehensive rationalization of all fisheries. By extending rights-based management to additional groundfish fisheries and thereby ending the race for fish in those fisheries, this FMP bookend has the potential to provide increased protection to the Bering Sea and GOA ecosystems.

If rights-based management systems include individual quotas on bycatch, they provide strong incentives to reduce bycatch because they internalize the cost of that bycatch. In turn, a reduction in bycatch can help protect bycatch species from overexploitation and maintain the overall ecosystem of which they could be an important part. Moreover, the experience with cooperatives in the BSAI pollock fishery shows that fishing could be spread out temporally as a result of rights-based management systems. This dispersal of fishing effort would reduce the potential for local depletions of fish stocks and the associated adverse impacts on marine mammals and other species.

As discussed in Section 4.7.11, the measures implemented under PA.2 are expected to have significantly or conditionally significant beneficial consequences for predator-prey relationships and diversity. In turn, these beneficial effects on the Bering Sea and GOA marine ecosystems and associated species are expected to lead to a conditionally significant increase in the levels of some of the benefits these ecosystems and species provide.

Cumulative Effects of PA.1 and PA.2

See Table 4.9-6 for a summary of the cumulative effects on the value of ecosystems under PA.1 and PA.2.

- **Direct/Indirect Effects**. Under this PA.1 and PA.2, the adverse effects that the Alaska groundfish fishery could have on marine ecosystems are reduced. PA.1 is predicted to have a beneficial but insignificant impact on the levels of benefits these ecosystems and associated species generate. PA.2 is predicted to have a conditionally significant beneficial impact.

- **Persistent Past Effects**. Persistent past effects on the level of benefits, including non-consumptive and non-use benefits, that marine ecosystems and associated species provide to the public include: an increase in public awareness of marine ecosystems; increased participation in recreational fishing and eco-tourism activities; and persistent past effects on ecosystems, as described in Section 4.9.10. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects include other fisheries, long-term climate changes and regime shifts, and other factors, as described in Section 4.9.10.2. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects**. Under PA.1 and PA.2, a cumulative effect is identified for benefits the public derives from marine ecosystems and associated species, including non-consumptive and non-use benefits, and the effect is judged to be insignificant and conditionally significantly beneficial, respectively. The external impacts of other fisheries, long-term climate changes and regime shifts, and other factors have the potential to contribute adversely to benefits the public derives from marine ecosystems and associated species.

4.9.10 Ecosystem Preferred Alternative Analysis

Ecosystems are populations (consisting of single species) and communities (consisting of two or more species) of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure (food web) and material cycles (movement of mass and energy among the groups). The following analyses of potential direct/indirect and cumulative effects of PA.1 and PA.2 apply to the BSAI and GOA ecosystems. Where available information allows, each ecosystem is addressed separately. In most cases, however, information is insufficient to allow individual consideration, and the two ecosystems are treated as a single entity.

As explained in Section 4.5.10, the analyses include numerous indicators representing potential direct, indirect, and cumulative effects of the alternative and of specific bookends, where applicable. Significance criteria and thresholds for the effect categories are presented in Table 4.1-7.

Direct/Indirect Effects PA.1 and PA.2 – Ecosystem

This section assesses the potential direct/indirect effects of PA.1 and PA.2 on the BSAI and GOA ecosystems.

Change in Pelagic Forage Availability

Pelagic forage availability is assessed primarily by evaluating population trends in pelagic forage biomass for species with age-structured population models. These include walleye pollock in the GOA (Figure H.4-17 of Appendix H), Bering Sea walleye pollock, and Aleutian Islands Atka mackerel (Figure H.4-18 of Appendix H). For other forage species (herring, squid, and the forage species group), bycatch trends are used as measures of the potential impact of the BSAI and GOA groundfish fisheries on forage availability (Figures H.4-19 and H.4-20 of Appendix H). Table 4.5-81 summarizes the average values from 2003 through 2008 for these measures and the percent change in the average values from the baseline amounts. Under PA.1, the estimated pelagic forage biomass for the age-modeled populations declines from the baseline in the BSAI and increases over the baseline in the GOA. Twenty-year biomass projections show similar trends. Average biomass, however, remains within the bounds of estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species increases in the BSAI and declines in the GOA. Estimates of forage biomass from food web models of the EBS indicate that this level of bycatch is probably a small proportion of the total forage biomass (Aydin *et al.* 2002), although because population-level assessments are lacking for some members of the forage species group, corresponding biomass estimates for these species are not available. Because average biomass projections for the age-modeled forage species remain within the estimated historical boundaries, and bycatch-based estimates for other forage species are small in relation to total forage biomass, PA.1 is determined to have insignificant effects on the BSAI and GOA ecosystems with respect to pelagic forage availability.

Under PA.2, pelagic forage biomass for the age-modeled species again declines from the baseline in the BSAI and increases over the baseline in the GOA. Twenty-year biomass projections show similar trends. As with PA.1, the estimated average biomass resides within the range of the estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species increases in the BSAI and declines in the GOA, although again, the lack of population-level assessments for some members of the forage species group prevents biomass projections for these species. Also, the extensive fishing closure areas proposed under both PA.1 and PA.2 may alter bycatch estimates in ways that cannot be accurately predicted. Because average biomass projections for the age-modeled forage species remain within the estimated historical boundaries, and bycatch-based estimates for other forage species are considered to be small in relation to total forage biomass (Aydin *et al.* 2002), PA.2 is determined to have insignificant effects on the BSAI and GOA ecosystems with respect to pelagic forage availability.

Spatial and Temporal Concentration of Fishery Impact on Forage

The spatial and temporal concentration of fishery impacts on forage species is assessed qualitatively by considering the potential for the alternative to concentrate fishing on forage species in regions utilized by predators that are tied to land, such as pinnipeds and breeding seabirds. Additionally, the possibility for concentrated fishing effort to result in an ESA listing or in the lack of recovery of a species that is already listed is also considered. PA.1 would continue the existing closures around Steller sea lion rookeries, trawl and fixed gear closures in nearshore and critical habitat areas, the ban on directed fishing for forage fish, and the spatial/temporal allocation of TAC for some BSAI and GOA species, resulting in an insignificant effect on forage species. In the GOA, identification of salmon savings areas along with establishing PSC limits are proposed measures under PA.1. In addition, BSAI pollock fisheries have shown increasing catch in northern fur seal foraging habitat, but more research is required to evaluate whether the amounts of pollock removed are having a population-level effect on fur seals. This type of catch trend data may be useful in the development of ecosystem indicators for future use in TAC-setting processes, as put forth under PA.1.

PA.2 would continue the existing closures around Steller sea lion rookeries with the possibility of designating critical habitat areas based on scientific information. In addition, modified Steller sea lion closures in the Aleutian Islands are also proposed. The existing ban on forage fish and spatial/temporal allocation of TAC for some BSAI and GOA species would continue. Maintaining current closed/restricted areas, with the potential for some of these areas to qualify as MPAs, could provide increased protection of northern fur seal foraging habitat from potential fishing effects. PA.2 proposes the prohibition of pollock bottom trawling in the GOA as well as continuing the existing ban in the BSAI. For these reasons, PA.2 is determined to have a conditionally significant beneficial effect on the spatial/temporal availability of forage, particularly for some marine mammals. Additional seabird avoidance measures in longline and trawl fisheries are proposed under PA.2, with emphasis on cooperation between NOAA Fisheries and USFWS to develop revised fishing methods that reduce incidental take for all seabird species. Although these measures may not result in significant changes in the spatial/temporal availability of forage to seabirds, it will be difficult to determine the potential effectiveness of the improved methods until they have been fully implemented.

Removal of Top Predators

Removal of top predators, either through directed fishing or bycatch, is assessed by evaluating the trophic level of the catch relative to the trophic level of the groundfish biomass (Figures H.4-21 through H.4-24 of Appendix H), bycatch levels of sensitive top predator species such as birds and sharks (Figures H.4-25 and H.4-26 of Appendix H), and a qualitative evaluation of the potential for catch levels to cause one or more top-level predator species to fall below biologically acceptable limits (MSST for groundfish; for other species, ESA listing or preventing recovery of an already-listed species). Trophic level of the catch in both the BSAI and GOA is a very stable property, changing less than 3 percent on average from the baseline, and trophic level of the groundfish species for which we have age-structured models changes less than one percent on average.

The above indicators result in no change in the evaluation of the importance of this effect relative to the baseline. The baseline determination shows that historical whaling has resulted in low present-day abundance of whale species in the North Pacific Ocean. PA.1 and PA.2 would not further impair the recovery of these species through direct takes. Similarly, it is not expected that levels of seabird and pinniped bycatch in groundfish fisheries would lead to an ESA listing for any of those populations or prevent any of the listed species from recovery under the ESA. Additional seabird avoidance measures in longline and trawl fisheries are proposed under PA.2, with emphasis on cooperation between NOAA Fisheries and USFWS to develop revised fishing methods that reduce incidental take for all seabird species. Although these measures may not result in significant changes to seabird populations, it will be difficult to determine the potential effectiveness of improved methods until implementation has taken place. Sections 4.9.7 and 4.9.8 discuss the potential effects of groundfish fishery direct takes on specific seabird and marine mammal populations under PA.1 and PA.2.

The effect of shark bycatch on shark populations is currently unknown, and further research focusing on population assessments and establishing reliable biomass estimates for these sensitive (late maturing, low fecundity, low natural mortality) species is needed to identify potential effects from the groundfish fisheries. As proposed in PA.2, breaking sharks (and additional species groups) out of the other species complex for TAC-setting purposes may result in an increased level of protection through a more species-specific TAC. As a result of implementing specific TAC-setting measures for species that have traditionally been included in the other species TAC category, improved management of these individual species may minimize potential population-level impacts resulting from bycatch mortality. In addition, improved observer coverage and species identification for non-target species, as proposed in PA.2, may provide improved bycatch data, further supporting the need for more comprehensive management of particular species within the other species group. Section 4.9.3 contains detailed information regarding potential cumulative effects of PA.1 and PA.2 on sharks, skates, and other cartilaginous fishes.

Stability in trophic level of the catch indicates that minimal effects have resulted from fishing impacts on target and PSC species top predators (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). PA.1 maintains current PSC limits for halibut in the BSAI and GOA while considering reducing these limits by 1 to 10 percent in the BSAI, if practicable. Further reduction in PSC limits for halibut are suggested under PA.2 for both the BSAI and GOA. Section 4.9.1 and 4.9.2 discuss direct, indirect, and cumulative effects associated with PA.1 and PA.2 for target species and Pacific halibut. Overall, potential effects of PA.1 and PA.2 on top predators are predicted to be insignificant and unknown.

<u>Introduction of Non-Native Species</u>

The introduction of non-native species through ballast water exchange and hull-fouling organism release from fishing vessels could potentially disrupt the Alaskan marine food web structure (Fay 2002). There have been 24 non-indigenous plant and animal species documented in Alaskan marine waters, primarily in shallow-water nearshore and estuarine ecosystems, with 15 of those species recorded in PWS. It is possible that most of these introductions were from tankers or other large commercial vessels that have large volumes of ballast exchange. However, exchange via fishery vessels that take on ballast from areas where invasive species have already been established and then transit through Alaskan inshore waters has been identified as a threat in a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). Consequently, this effect is evaluated as conditionally significant adverse in the baseline condition.

Total groundfish catch levels are used as an indicator of potential changes in the amount of these releases by groundfish fishery vessels (Figures H.4-27 and H.4-28 of Appendix H and Table 4.1-7). Under PA.1 and PA.2, catch levels increase in the BSAI. PA.2 results in decreasing catch levels in the GOA relative to the baseline, while GOA catch under PA.1 increases. These projected catch levels are similar to recent catches in these areas, indicating a similar level of effort and resulting in a similar potential for fishing vessel introduction of non-native species through ballast water exchange or hull-fouling organism release.

Consequently, potential effects of PA.1 and PA.2 on the introduction of non-native species from fishing vessels and gear are insignificant compared to the baseline condition.

Energy Flow and Balance

As discussed in Section 3.10, fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal to the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Baseline energy removals, in the form of total catch, were less than one percent of the total system energy as determined by mass-balance modeling of the system and were determined to have an insignificant impact on the ecosystem baseline. Predicted catch removals under PA.1 (Figures H.4-27 and H.4-28 of Appendix H, Table 4.5.-142) are similar to those modeled in FMP 3.1 and are determined to be insignificant with respect to the potential for producing changes in system biomass, respiration, production, or energy cycling that are outside the range of natural variability (Table 4.9-7). Predicted catch removals under PA.2 are presumed to show similar trends to FMP 3.2 (Figures H.4-27 and H.4-28 of Appendix H, Table 4.5-81), thus increasing by an estimated one percent in the BSAI and decreasing by an estimated 7 percent in the GOA relative to the baseline. These changes are also determined to be insignificant.

Energy re-direction, in the form of discards, fishery offal production, or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the ecosystem. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms and make them more vulnerable to predation. Discards and offal production can cause local enrichment and changes in species composition or water quality if discards or offal returns are concentrated in confined areas such as estuaries, bays, and lagoons. These effects were determined to be insignificant at the ecosystem baseline level. It is expected that trends in total discards for PA.1 will be similar to those shown under FMP 3.1 (Table 4.5-81, Figures H.4-29 and H.4-30 of Appendix H). These result in increases of less than one percent in the BSAI and decreases by approximately 8 percent in the GOA relative to the baseline. Trends in total discards (Table 4.5-81, Figures H.4-29 and H.4-30 of Appendix H) under PA.2 are presumed to decrease approximately 20 to 25 percent in the BSAI and 40 and 50 percent in the GOA relative to the baseline, as observed under FMP 3.2. These changes are considered minimal in comparison to historical amounts of discards and are insignificant to ecosystem-level energy cycling characteristics.

Change in Species Diversity

As explained in Section 3.10, commercial fishing can alter different facets of diversity. Species diversity, defined as the number of different species in an ecosystem, can be altered if fishing results in removal of one or more species from the system. Fishing can also alter functional diversity in terms of both trophic and structural habitat characteristics. Functional diversity can be altered with respect to trophic characteristics if removal or depletion of a trophic guild member occurs. Changes to distribution of biomass within a trophic guild may also result. From a structural habitat standpoint, functional diversity can be altered or damaged if benthic fishing methods such as bottom trawling remove or deplete organisms that provide structural habitat for other species (e.g., corals, sea anemones, sponges). Impacts to genetic diversity from fishing can occur by selectively removing faster-growing fish or removing spawning aggregations that may exhibit genetic characteristics that are different from other spawning aggregations. Larger, older fishes may be more heterozygous (i.e., demonstrating wider genetic differences or diversity), and some stock structures may have a genetic component (see review in Jennings and Kaiser 1998). Consequently, one would expect a decline in genetic diversity within biological populations receiving heavy exploitation by fisheries.

Significance thresholds for effects of fishing on species diversity are defined as catch removals resulting in the biomass of one or more species (target or non-target) falling below, or not recovering from levels already below, minimum biologically acceptable limits (MSST for target species, ESA listing for non-target) (Table 4.1-7). For sensitive species groups (those having low population turnover rates) that lack population estimates (e.g., skates, sharks, grenadiers, and sessile invertebrates inhabiting HAPC), bycatch data indicate the potential for fishing impacts to affect species diversity (Table 4.5-81, Figures H.4-31 and H.4-32 of Appendix H). Closed areas provide protection to these groups, particularly to less-mobile species like HAPC biota. Baseline determinations were insignificant for target and non-target species, and unknown for species groups lacking population estimates and bycatch data, including HAPC species.

Under PA.1, currently closed areas (including Steller sea lions closures) would be maintained, identification and designation of EFH and HAPC are proposed, and current no-trawl zones and fixed-gear restrictions would stay in place. Although it is unknown whether bycatch amounts of HAPC biota would be at levels high enough to reduce these species to minimum population thresholds, area closures would likely be effective in preventing population-level impacts on these sessile animals. Under PA.2, the estimated bycatch of HAPC biota is expected to decrease in the BSAI and GOA (Table 4.5-81). This FMP would also provide substantial increases in closed areas such as no-trawling MPAs and no-take reserves across a range of habitat types, review of all existing closures for qualification as MPAs, establishment of an Aleutian Islands management area to protect coral and other living habitat species, and modification of 2002 Steller sea lion with designation of critical habitat according to scientific data and assessment information. These measures may further reduce the bycatch of HAPC biota. In addition, the adoption and use of key ecosystem indicators to modify TAC-setting processes may provide further protection to sensitive groups such as HAPC biota until more life history information becomes available. Although forage species population levels are not known, their relatively high population turnover rates, along with the ban on directed fisheries for forage species in PA.1 and PA.2, are considered effective protection measures for minimizing potential population-level effects.

On the basis of the preceding considerations, potential effects of PA.1 and PA.2 on species diversity are considered insignificant and unknown. More comprehensive survey data and life history parameter determinations for skates, sharks, grenadiers, and other species groups may help to determine population status and establish additional protection measures that could minimize adverse impacts from fishing.

Change in Functional Diversity

Functional (either trophic or structural habitat) diversity can be altered through fishing if selective removal of one member of a functional guild results in increases in other guild members. A functional guild is a group of species that utilize resources within the ecosystem in similar ways. Significance thresholds are characterized by catch removals resulting in a change in functional diversity outside the range of natural variability observed for the system (Table 4.1-7). Indicators for the magnitude of this effect include qualitative evaluation of guild or size diversity changes relative to fishery removals, changes in bottom gear effort that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild. Members of the HAPC biota guild serve important functional roles in providing fish and invertebrates with structural habitat and refuge from predation. The abundance level of these structural species necessary to provide protection is not known, and it may be important to retain populations of these organisms and maintain wide spatial distribution to enable them to fulfill their various functional roles. Some of these organisms have life-history traits that make them very sensitive to population-level impacts resulting from fishing. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Present and proposed Steller sea lion trawl closures are spread throughout the Aleutian Islands, but these closures may be further inshore than most of the coral. For this reason, the area closures proposed under PA.1 and PA.2 may not be sufficient to provide additional protection for these sensitive organisms in all areas throughout the BSAI and GOA.

Under PA.1, species composition and amounts of removals, bottom gear effort, and bycatch of HAPC biota (Table 4.5-81, Figures H.4-31 and H.4-32 of Appendix H) would remain similar to the comparative baseline, in which fishing impacts on functional guild diversity are determined to be insignificant for trophic diversity and conditionally significant and adverse for structural habitat diversity. Some of the area closures for PA.2 have been developed with corals and other living habitat species in mind. If implemented, these measures may improve protection throughout their broad spatial distribution, particularly in the Aleutian Islands. Thus, PA.2 is determined to have significantly beneficial effects on structural habitat diversity relative to the baseline, whereas PA.1 would result in an insignificant change from the baseline condition. In addition, possible effects of PA.2 on trophic diversity, species composition, and removal of target species relative to the baseline are regarded as insignificant.

Change in Genetic Diversity

Genetic diversity can be affected by fishing through heavy exploitation of certain spawning aggregations or systematic targeting of older age classes that tend to have greater genetic diversity. Under PA.1 and PA.2, target species are not expected to fall below their respective MSST, spatial/temporal management of TAC would not change, and similar catch and selectivity patterns in the fisheries would apply. The PA would result in insignificant impacts to genetic diversity. However, a baseline condition for genetic diversity remains unknown for many species, and the potential effects of fishing on genetic diversity under PA.1 and PA.2 are also largely unknown.

Cumulative Effects Analysis PA.1 – Ecosystems

The following section describes the potential cumulative effects of PA.1 on the ten ecosystem indicators explained in Section 4.5.10. These potential cumulative effects are summarized in Table 4.5-89. Data and calculations supporting the energy removal analyses for all alternatives are presented in Table 4.5-81.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The direct/indirect effects of PA.1 on pelagic forage availability are expected to be insignificant. Fishery-induced changes, including bycatch-related effects on forage species, are predicted to remain within the natural level of abundance or variability for prey species relative to predator demands (Table 4.9-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries and targeted domestic catches of pollock and Atka mackerel are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS of 1989 suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability is expected in the event of a large petroleum spill. The conditions under which this effect may be significant relate to the areas affected by, and seasonal timing of, the spill. If these conditions coincide with spawning locations and times, a significantly adverse cumulative effect on pelagic forage availability would most likely result. Additive or interactive contributions from State of Alaska commercial fisheries and subsistence fish harvests are not expected to be significant. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial and Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The direct/indirect effects of the spatial and temporal concentration of fishing effort under PA.1 on pelagic forage availability are expected to be insignificant. PA.1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial/temporal allocation of TAC for pollock and Atka mackerel, which together would result in insignificant impacts to forage species.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, the State of Alaska directed herring fishery, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may persist presently and into the future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been correlated with changes in recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may persist on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and locations that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlap with the groundfish fishery is more likely to be temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial and temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this potential cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning would most likely produce population declines and adversely affect other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial and temporal distributions of pelagic forage species in ways that are synergistic with spatial and temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the future from synergistic interactions between spatial and temporal concentrations of the BSAI and/or GOA groundfish fishing effort. The conditions under which this potential effect may become significant relate to location and timing. If the fishing efforts of the State of Alaska directed fisheries (primarily herring fisheries) and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could become significantly depressed, leading to impairment of the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.5-89). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial and temporal distributions of pelagic forage species in ways that might reduce or intensify this potential Cumulative Effects.

<u>Removal of Top Predators</u>

- **Direct/Indirect Effects.** The implementation of PA.1 is predicted to have insignificant direct/indirect effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This FMP would not impair the continued recovery of whale populations still reduced through direct take in the past. Predicted levels of seabird and marine mammal bycatch in the groundfish fisheries are not expected to lead to the listing of these species or prevent their recovery under the ESA. Because there is little available information on shark bycatch, the direct/indirect effect of this FMP on shark populations is unknown.

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the currently depressed abundance of whale species in the North Pacific Ocean. State of Alaska directed groundfish fisheries have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than those observed in the past. Adverse effects from these past harvests may persist on some populations today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove sustainable numbers of Pacific halibut, a top predator. The current management plan is likely to continue in the future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). Seabird bycatch and resulting direct mortality are expected to continue annually in North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-3.7.19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish harvests in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future, with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea may result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on populations of top predators could result primarily from continued seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. The conditions under which this cumulative effect may become significant include the continuation of seabird bycatch in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and this could intensify or reduce this potential cumulative effect by influencing recruitment.

<u>Introduction of Non-Native Species</u>

- **Direct/Indirect Effects.** Under PA.1, projected catch levels would maintain a potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms similar to that which currently exists under baseline conditions. Therefore, the potential direct/indirect effect of PA.1 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan marine waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including disease and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in the State of Alaska directed fisheries will continue to be potential sources for exotic species introductions. In addition, commercial shipping, including cruise ships, barges, and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapees and releases of farmed Atlantic salmon from Washington and British Columbia net-pens could eventually establish runs in the GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could affect wild stocks. A future regime shift or long-term warming trend may deplete the current protection that colder conditions provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with PA.1, it is conceivable that viable populations could become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect on indigenous species (Table 4.5-89). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that would allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA. External sources that could contribute to this potential cumulative effect in the future include fishing vessels participating in the IPHC and State of Alaska commercial fisheries and commercial ships such as tankers and cruise ships, all of which can introduce non-native species through the release of ballast water and hull-fouling organisms (Fay 2002). In addition, Atlantic salmon released or escaped from coastal net-pen farms could establish viable runs throughout coastal areas of Alaska in the future (ADF&G 2002a).

<u>Energy Removal</u>

- **Direct/Indirect Effects.** The direct/indirect effects of PA.1 on energy removal are expected to be insignificant when compared to current baseline conditions. Therefore, estimated energy removals under PA.1 would not have the potential to produce changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.9-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch. These removals are regulated and mitigated and continue today (Section 3.10). Aggregate levels of biomass removed by unregulated past human activities may have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased, and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (donut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that they are viewed as only partly comparable systems. Their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of PA.1 is predicted to have an insignificant cumulative effect on energy removal in the future. The overall biomass removal from internal and external fisheries is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.5-89).

Energy Redirection

- **Direct/Indirect Effects.** The direct/indirect effects of PA.1 on energy redirection are expected to be insignificant. Predicted effects are minimal relative to the baseline, and fishery discarding and offal production practices under PA.1 would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.9-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process, and it is difficult to know whether past changes in energy cycling and in pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than they were 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of PA.1 is predicted to have an insignificant cumulative effect on energy redirection. The predicted direct/indirect effects under PA.1 in combination with external sources is not expected to depart from the comparative baseline condition sufficiently to produce long-term changes outside the range of natural variability. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through USEPA and ADEC permitting programs, respectively.

Change in Species Diversity

- **Direct/Indirect Effects.** The expected direct/indirect effects of PA.1 on species diversity are rated as unknown for skates, sharks, grenadiers, and other non-managed species and insignificant for other species groups. It is unknown whether bycatch of HAPC biota would result in levels high enough to bring these species to minimum population thresholds, but area closures would likely be sufficient to prevent species removal for these sessile animals. Predicted catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate species (including HAPC species) are susceptible to impacts from bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, reducing populations of some seabird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated for some declines through bycatch. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, the rates are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water discharge and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotic species to establish viable populations.

- **Cumulative Effects.** Under PA.1, a conditionally significant adverse effect on species diversity could result from high levels of seabird bycatch in the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may, at some time in the future, establish viable populations that could alter species diversity by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year (e.g., belugas) could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species. Under some combination of these conditions, the biomass of one or more species could fall below, or be kept from recovering from levels already below, minimum biologically acceptable limits (Table 4.5-89).

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Under PA.1, the predicted direct/indirect effects of the groundfish fisheries on trophic diversity are rated as insignificant because they are expected to be similar to the comparative baseline conditions, for which fishing effects on trophic diversity are also rated as insignificant.

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, research on this type of effect in the BSAI and GOA has been minimal.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead trout (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Exotic species introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by expanding some trophic levels and contracting others. In addition, a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic species populations.

- **Cumulative Effects.** The implementation of PA.1 could produce a conditionally significant adverse effect on trophic diversity. The primary condition for this effect is largely speculative: a climatic regime shift could result in a trophic guild containing one or more groundfish fishery target species becoming more vulnerable to fishing pressure. A regime shift in the future, similar to well-documented examples that have occurred in the past (Sections 3.3 and 3.10.1.5), may affect species diversity within a trophic guild by reducing the productivity or shifting the distributional range of one or more member species. If this climatic effect went undetected and without compensatory adjustments to fishing effort, the continued removal of particular target species, especially slow-growing species such as rockfish, could decrease their representation within trophic guilds (Heifitz *et al.* 2001).

<u>Change in Functional (Structural Habitat) Diversity</u>

- **Direct/Indirect Effects.** The issue of concern with respect to functional diversity is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures for habitat by other species, including economically important groundfish species and their prey. Present (comparative baseline) trawl closures to protect Steller sea lion habitat are spread throughout the Aleutian Islands, but these closures are in nearshore waters that may not include all areas of living structural habitat species. Under PA.1, the species composition and biomass levels of removals, bottom gear effort and resulting bycatch amounts of HAPC biota, and areas closed to trawling relative to coral distribution are similar to the baseline. Therefore, the change from baseline conditions that would result from implementation of this FMP is evaluated as insignificant with respect to structural habitat diversity.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years.

  Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill could affect areas where these sensitive bottom-dwelling organisms live and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of PA.1, rated insignificant, could contribute to a conditionally significant adverse cumulative effect on structural habitat diversity under any of the following three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could add to the direct/indirect effects of bottom trawling by the groundfish fisheries on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity, and thus the population size, as well as the distribution, of bottom-dwelling invertebrates that provide structural habitat.

Change in Genetic Diversity

- **Direct/Indirect Effects.** Under PA.1, target species are not expected to fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to the comparative baseline conditions. Consequently, the direct/indirect effects of the groundfish fisheries on genetic diversity are expected to be insignificant under this FMP. However, baseline genetic diversity remains unknown for many species, and the actual direct/indirect effects that fishing may have on genetic diversity are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was significantly altered. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (i.e., dating from an earlier period when fishing was less intensive), then genetic diversity tends to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be determined in the absence of reliable data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapees from coastal net-pen farms in Washington and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Future climate changes could alter the productivity and distribution of individual species and enable exotic species to establish viable populations.

- **Cumulative Effects.** The implementation of PA.1 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. For this reason, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the reasonably foreseeable future.

Cumulative Effects Analysis PA.2 – Ecosystems

The following section briefly discusses the potential cumulative effects of PA.2 on the ten ecosystem indicators explained in Section 4.5.10. The cumulative effects conclusions are summarized in Table 4.5-89. Data and calculations supporting the energy removal analyses for the alternatives are presented in Table 4.5-81.

<u>Change in Pelagic Forage Availability</u>

- **Direct/Indirect Effects.** The direct/indirect effects of PA.2 on pelagic forage availability are expected to be insignificant. Fishery-induced changes, including bycatch-related effects on forage species, would remain within the natural level of abundance or variability for prey species relative to predator demands (Table 4.9-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed between 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population size, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could occur in the event of a large petroleum spill. The conditions under which this effect could be significant relate to the areas affected by, and seasonal timing of, the spill. If these conditions coincide with spawning locations and times, a significantly adverse effect on pelagic forage availability would most likely result. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial and Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** PA.2 would continue the existing closures around Steller sea lion rookeries, with the possibility of designating critical habitat areas based on scientific information. In addition, modified Steller sea lion closures in the Aleutian Islands are also proposed. The existing ban on forage fish and spatial/temporal allocation of TAC for some BSAI and GOA species would continue. These measures would not produce a significant change in the spatial/temporal availability of forage to seabirds, but they would be notable improvements over the baseline for top-predator fish and marine mammals. Maintaining current closed/restricted areas, with the potential for some of these areas to qualify as MPAs, could provide increased protection to northern fur seal foraging habitat from potential fishing effects. PA.2 proposes the prohibition on Pollock bottom trawl in the GOA as well as the existing ban in the BSAI. For these reasons, PA.2 is predicted to have a conditionally significant beneficial effect on the spatial/temporal availability of forage, particularly for some marine mammals, but insignificant effects on forage availability to seabirds.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may persist presently and into the future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been correlated with changes in recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may persist on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and locations that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlap with the groundfish fishery is more likely to be temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial and temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning would most likely produce population declines and adversely affect other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial and temporal distributions of pelagic forage species in ways that are synergistic with spatial and temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the future through synergistic interactions between spatial and temporal concentrations of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries (primarily herring fisheries) and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be significantly depressed, thereby impairing the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.5-89). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial and temporal distributions of pelagic forage species in ways that might reduce or intensify this potential cumulative effects.

Removal of Top Predators

- **Direct/Indirect Effects.** The implementation of PA.2 is predicted to have insignificant direct/indirect effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This FMP would not impair the continued recovery of whale populations still reduced through direct take in the past. Predicted levels of seabird and marine mammal bycatch in the groundfish fisheries would not lead to listing of these species or prevent recovery of currently listed species under the ESA. Because there is little available information on shark bycatch, the effect of this FMP on shark populations is unknown.

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of shark, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the currently depressed abundance of whale species in the North Pacific Ocean. State of Alaska directed groundfish fisheries have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than those observed in the past. These past harvests may have persistent effects on some populations today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove sustainable numbers of Pacific halibut, a top predator. The current management plan is likely to continue in the future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). Seabird bycatch and resulting direct mortality are expected to continue annually in North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-3.7.19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future, with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea may result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on populations of top predators could result primarily from the contribution of continued seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. The conditions under which this potential cumulative effect could become significant include continued bycatch of seabirds in conjunction with a large fuel or oil spill and incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and this could intensify or reduce this potential cumulative effect by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** Under PA.2, the predicted catch levels indicate that this FMP would have the same potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms that currently exists under baseline conditions. Therefore, the effect of PA.2 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan marine waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including disease and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to act as potential sources for exotic species introductions. In addition, commercial shipping, including cruise ships, barges, and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapees and releases of farmed Atlantic salmon from Washington and British Columbia net-pens could eventually establish runs in the GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could affect wild stocks. A future regime shift or long-term warming trend may deplete the current protection that colder conditions may provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with PA.2, it is conceivable that viable exotic populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse effect on indigenous species (Table 4.5-89). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that enables exotic species, currently limited by low seawater temperatures, to establish viable populations in the BSAI and/or GOA. External sources that could contribute to this potential cumulative effect in the future include fishing vessels participating in the IPHC and State of Alaska commercial fisheries, and commercial ships such as tankers and cruise ships, all of which can introduce non-native species through the discharge of ballast water and release of hull-fouling organisms (Fay 2002). In addition, Atlantic salmon released or escaped from coastal net-pen farms could establish viable runs in coastal areas of southeast Alaska in the future (ADF&G 2002a).

<u>Energy Removal</u>

- **Direct/Indirect Effects.** The direct/indirect effects of PA.2 on energy removal are expected to be insignificant. Baseline energy removals, in the form of total catch, are less than one percent of the total ecosystem energy, as estimated by mass-balance modeling, and were determined to have an insignificant impact on the ecosystem baseline. Estimated energy removals under PA.2 would not exhibit potential for producing significant changes to system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.9-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch. These removals are regulated and mitigated and continue today (Section 3.10). Aggregate levels of biomass removed by unregulated past human activities may have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (donut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that they are viewed as only partly comparable systems. Their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of PA.2 is predicted to have an insignificant cumulative effect on energy removal in the future. The cumulative biomass removal from internal and external fisheries under this FMP is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.5-89).

Energy Redirection

- **Direct/Indirect Effects.** The direct/indirect effects of PA.2 on energy redirection are expected to be insignificant. Predicted effects are minimal relative to the baseline and would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.9-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process, and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than they were 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of PA.2 is predicted to have an insignificant cumulative effect on energy redirection. Even with the decreases in discards predicted (Table 4.5-81), the cumulative effect of PA.2 in combination with external sources is not expected to depart from the comparative baseline condition enough to produce long-term changes outside the range of natural variability. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through USEPA and ADEC permitting programs, respectively.

Change in Species Diversity

- **Direct/Indirect Effects.** The expected direct/indirect effects of PA.2 on species diversity are rated as unknown for skates, sharks, grenadiers, and other non-managed species, and insignificant for other species groups. This FMP would also provide substantial increases in closed areas such as no-trawling MPAs and no-take reserves across a range of habitat types, review of all existing closures for qualification as MPAs, establishment of an Aleutian Islands management area to protect coral and other living habitat species, and modification of 2002 Steller sea lion protection measures with designation of critical habitat according to scientific data and assessment information. These closures may result in further reductions in HAPC biota bycatch. The adoption and use of key ecosystem indicators for modifying TAC-setting processes may also provide further protection to sensitive groups such as these until more is learned about their life histories. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds. Although forage species population levels are not known, their relatively high turnover rates and the ban on forage fish fisheries under this FMP are considered sufficient to protect them from falling below minimum biologically acceptable limits.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate species (including HAPC species) are susceptible to impacts from bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated for some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, the rates are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapees from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotic species to establish viable populations.

- **Cumulative Effects.** Under PA.2, a conditionally significant adverse effect on species diversity could result from continued seabird bycatch in the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, introduced exotic species may establish viable populations that could alter species diversity by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of subsistence harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate successful establishment of viable populations of exotic species.

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Potential effects on trophic diversity relate to changes in the variety of species within trophic guilds. Under PA.2, the predicted direct/indirect effects of the groundfish fisheries on trophic diversity are rated as insignificant. Expected results are similar to the comparative baseline condition, for which fishing effects on trophic diversity are also rated as insignificant.

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly altered the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, minimal research on this type of effect has been conducted for the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead trout (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Exotic species introduced to BSAI and GOA waters from fishing vessels and commercial shipping could lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by expanding some trophic levels and contracting others. In addition, a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic species populations.

- **Cumulative Effects.** The implementation of PA.2 could result in a conditionally significant adverse effect on trophic diversity. The primary condition for this potential effect is largely speculative—a climatic regime shift could make a trophic guild containing one or more groundfish fishery target species more vulnerable to fishing pressure. A regime shift in the future, similar to well-documented examples that have occurred in the past (Sections 3.3 and 3.10.1.5), could also decrease species diversity within a trophic guild by reducing the productivity or shifting the distributional range of one or more member species. If this climatic effect went undetected and without compensatory adjustments to fishing effort, the continued removal of particular target species, especially slow-growing species such as the rockfish, could decrease their representation within trophic guilds (Heifitz *et al.* 2001).

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to structural habitat diversity is the removal of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures used as habitat by other species, including economically important groundfish species and their prey. Some of the area closures proposed under PA.2 have been developed with corals and other living habitat species in mind. If implemented, these measures could improve protection of HAPC biota throughout their broad spatial distribution, particularly in the Aleutian Islands. With respect to structural habitat diversity, PA.2 is thought to provide significantly beneficial effects relative to the baseline.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill could affect areas where these sensitive bottom-dwelling organisms live and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of PA.2, rated significantly beneficial, could contribute to a conditionally significant beneficial cumulative effect on structural habitat diversity. This rating is conditional because the direct/indirect effect of PA.2 could be offset under any of the following three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could counteract, to an unknown extent, the potential benefits of PA.2 on HAPC biota. Second, a large petroleum spill could also damage or destroy these sensitive organisms. Third, a change in seawater temperature resulting from a future climatic regime shift could reduce the productivity, population size, and distribution of bottom-dwelling invertebrates that provide structural habitat.

Change in Genetic Diversity

- **Direct/Indirect Effects.** Under PA.2, target species are not expected to fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to the comparative baseline conditions. Consequently, the direct/indirect effects of the groundfish fisheries on genetic diversity are expected to be insignificant under PA.2. However, baseline genetic diversity remains unknown for many species, and the actual effects that fishing may exert on genetic diversity are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was significantly altered. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity tends to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be determined in the absence of reliable data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Future climate changes could alter the productivity and distribution of individual species and enable exotic species to establish viable populations.

- **Cumulative Effects.** The potential cumulative effect of PA.2 on genetic diversity is predicted to be insignificant. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, introduction of exotic species through commercial shipping traffic, and climatic facilitation of viable exotic populations have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. For this reason, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the reasonably foreseeable future.

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