4.7 Alternative 3 Analysis

The goal of Alternative 3 is to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and, where appropriate and practicable, increased habitat protection and additional bycatch constraints. This alternative is described in detail in Section 2.6.4.

4.7.1 Target Groundfish Species Analysis

This section examines the potential direct, indirect, and cumulative effects that the implementation of Alternative 3 is expected to have on the target groundfish species. The potential effects of two policy "bookends" are analyzed, FMP 3.1 and FMP 3.2. These represent the policy boundaries of Alternative 2. As actually implemented, Alternative 3 could include policy measures anywhere within the range between the two bookends. The impact analyses start with the baseline (2002) status of the BSAI and GOA target groundfish stocks described in Section 3.5.1, including past trends that are likely to persist into the foreseeable future. Then, a computer-based analytic model is used to project how specific characteristics of the target groundfish stocks would respond directly and indirectly to management actions under each FMP. These projections from the model are the predicted direct and indirect effects (impacts) of the FMP on the target groundfish stocks. Section 4.1.5 describes the analytic model and explains how it is applied.

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

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

Direct Effects

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 FMPs 3.1 and 3.2 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.7-1. 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 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.

4.7.1.1 Pollock

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA pollock for each of the bookends under Alternative 3. Numerous fishery management actions have been implemented that affect the pollock fisheries in the EBS and GOA. These actions are described in more detail in Sections 3.5.1.1 and 3.5.1.15 of this Programmatic SEIS. Pollock is managed as separate stocks in the BSAI and GOA, and falls under Tier 1 in both the BSAI and GOA groundfish FMPs.

Direct/Indirect Effects of FMP 3.1

Under FMP 3.1, the following measures would be implemented:

- Sharks and skates would be removed from the “Other Species” category and given their own TAC, and criteria for separating individual stocks from stock complexes would be developed.

- The FMP would require that the TAC for each stock or stock complex be set no higher than the ABC.

- MSSTs for stocks in Tiers 1-3 would be specified in the FMPs, and the resources and time frame necessary to specify MSSTs for stocks in Tiers 4-6 would be identified, and a list of Tier 4-6 stocks prioritized for future MSST specification would be developed.

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 3.1, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.3 million mt in 2004, then stabilize to about 11.6 million mt. The 2003-2007 average total biomass is 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. Given that under FMP 3.1 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 this FMP from a 2003 low of 800,000 mt to 1,240,000 mt by 2007. The average biomass over this period is expected to be 1,040,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-23 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.4-1 of Appendix H. Under FMP 3.1, projections indicate that EBS pollock spawning biomass will decrease to about 78 percent of the 2002 level by 2007. The projected average for 2003-2007 is 3.05 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since under FMP 3.1 these areas are kept at bycatch-only levels, 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 240,000 mt by 2007 under FMP 3.1. This is above the estimated B_{msy} level of 210,000 mt although the average from 2003-2007 is 188,000 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 40 percent and average 0.243 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 51 percent in 2003, decreasing to 46 percent by 2007; the average implied SPR rate of fishing from 2003-2007 is 47 percent (Table H.4-1 of Appendix H). Fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under FMP 3.1 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.126 in 2003 followed by increases to 0.172 by 2007. The values for $F_{35\%}$ and $F_{40\%}$ are 0.350 and 0.294, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 60 percent for the period 2003-2007. This fishing mortality rate pattern is due to the fact that under this alternative, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$ (Table H.4-23 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 FMP 3.1, an average of 1.46 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial/temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period.

In the GOA, pollock fishery in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.1. Under FMP 3.1, an average of 75,700 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 111,300 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.

Status Determination

Under FMP 3.1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For FMP 3.1, GOA pollock spawning biomass is below the B_{msy} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Age and Size Composition

Under FMP 3.1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.50 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.07 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under FMP 3.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of Alternative 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under FMP 3.1 (for the period 2003-2007).

Summary of Effects of FMP 3.1 on Pollock

Because the pollock are fished at less than the OFL and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.1 are considered insignificant. Fishing rates are well within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity. Based on extended 20-year projections (with the same model assumptions as used in the base 2003-2007 period), both the EBS and GOA pollock are expected to stabilize with catches lower than the expected long-term F_{ABC} catch levels and spawning biomass levels above the B_{msy} levels (Table 4.7-1).

Cumulative Effects of FMP 3.1

Cumulative effects for EBS pollock are summarized in Table 4.5-1.

EBS Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 3.1 (see Section 4.7.1.1).

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

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

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

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be insignificant under the FMPs (see 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 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 potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under each FMP; and 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/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.7.1.1).

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

- **Reasonably Foreseeable Future External Effects.** The Russian and State of Alaska pollock fisheries 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 potential 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 FMP 3.1 for the spatial/temporal concentration; and 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 FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see above). However, as discussed under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.
- **Persistent Past Effects.** While lingering population level effects from past foreign 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 potential adverse effects. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown in Table 4.5-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

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

- **Persistent Past Effects.** Past effects identified for EBS 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. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

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

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

GOA Pollock

Cumulative effects for GOA pollock are summarized in Table 4.5-2.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 3.1 (see Section 4.7.1.1).

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

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

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

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMPs 3.1 (see direct/indirect effects discussion above).

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

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

- **Cumulative Effects.** Cumulative effects for change in biomass are identified; and the effects 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 FMP 3.1, the stock is expected to be above MSST for the years 2003-2007 (see direct/indirect effects discussion). Therefore, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

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

- **Reasonably Foreseeable Future External Effects.** 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 FMP 3.1; and the effects are considered to be 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 FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see above). However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.

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

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

- **Cumulative Effects.** Cumulative effects are identified for prey availability; and the effects 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 FMP 3.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stock include past foreign, JV, and, State of Alaska, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from these intense efforts (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 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 pollock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability for FMP 3.1; 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.

Direct/Indirect Effects of FMP 3.2

FMP 3.2 extends several of the measures proposed in Alterative 3.1, including:

- Biological reference points used in the tier system would be made taxon-specific where appropriate (for example, max F_{ABC} for Tier 3 rockfish stocks could be capped at $F_{60\%}$ rather than $F_{40\%}$), and scientifically justifiable methods for adjusting max ABC to account for statistical uncertainty in various tiers would be developed, implemented, and updated as appropriate.

- The OY would be specified separately for each stock or stock complex and set equal to the respective TAC.

- MSSTs would be specified in the FMPs for priority stocks in Tiers 4-6 as the necessary resources became available.

- A set of ecosystem indicators would be formally adopted and used in the TAC-setting process.

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 3.2, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.1 million mt in 2005, then stabilize to about 11.4 million mt. The 2003-2007 average total biomass is estimated at 11.3 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. If under FMP 3.2 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 this FMP from a 2003 low of 800,000 mt to 1,270,000 mt by 2007. The average biomass over this period is expected to be 1,060,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-23 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.4-1 of Appendix H. Under FMP 3.2, projections indicate that EBS pollock spawning biomass will decrease to about 78 percent of the 2002 level by 2007. The projected average for 2003-2007 is 2.99 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. If under FMP 3.2 these areas are kept at bycatch-only levels, 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 FMP 3.2. This is above the estimated B_{msy} level of 210,000 mt although the average from 2003-2007 is 195,000 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 33 percent and average 0.249 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 49 percent in 2003, decreasing to 47 percent by 2007; the average implied SPR rate of fishing from 2003-2007 is 47 percent (Table H.4-1 of Appendix H). If under this FMP pollock are maintained at bycatch-only status, then the fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under FMP 3.2 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.101 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 alternative, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$ (Table H.4-23 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 (January 20-March). Under FMP 3.2, an average of 1.48 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial/temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period (provided these regions maintain a bycatch-only status).

In the GOA, pollock fishery in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.15. Under FMP 3.2, an average of 64,100 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 96,400 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.

Status Determination

Under FMP 3.2, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For FMP 3.2, GOA pollock spawning biomass is below the B_{MSY} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Age and Size Composition

Under FMP 3.2, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.50 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 FMP 3.2.HabitatMediatedImpacts

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under FMP 3.2 (for the period 2003-2007).

Summary of Effects of FMP 3.2 – Pollock

Because the pollock are fished at less than the OFL and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.2 are considered insignificant. Fishing rates are well within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity. Based on extended 20-year projections (with the same model assumptions as used in the base 2003-2007 period), both the EBS and GOA pollock are expected to stabilize with catches lower than the expected long-term F_{ABC} catch levels and spawning biomass levels above the B_{MSY} levels.

Cumulative Effects of FMP 3.2 – EBS Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 3.2 (see Section 4.7.1.1).

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

- **Reasonably Foreseeable Future External Effects.** Removals of pollock that occur in the Russian pollock fishery are considered to be a potential adverse contributor while removals in the State of Alaska pollock fisheries are not considered to be contributors to fishing mortality in the cumulative case. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

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

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be insignificant under the FMP (see Section 4.7.1.1).

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are the same as those described for FMP 3.1 and include the Russian and State of Alaska pollock fisheries, and marine pollution.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under the FMP; and 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/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.7.1.1).

- **Persistent Past Effects.** Past effects under FMP 3.2 are identical to those described for FMP 3.1 and include lingering beneficial effects on reproductive success.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, the Russian and State of Alaska pollock fisheries have the potential to cause adverse effects on genetic structure, and 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 for the spatial/temporal concentration; and 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 FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion above). However, it is determined that the FMPs would have insignificant effects on pollock prey availability.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species could have potential beneficial or potential adverse effects (see direct/indirect effects discussion for FMP 3.1). Marine pollution has been identified as a reasonably future external contributing factor, and the other fisheries shown in Table 4.5-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the FMP; and 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 FMP, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, as described in the direct/indirect effects section, the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS 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. 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.** As described for FMP 3.1, adverse effects are possible from the Russian and State of Alaska fisheries and marine pollution. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be either beneficial or adverse.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under FMP 3.2; and the effects on the EBS pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

Cumulative Effects of FMP 3.2 – GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 3.2 (see Section 4.7.1.1).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, catch and bycatch of pollock in the State of Alaska pollock fisheries, and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Marine pollution is identified as having a potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

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

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 3.2 (see direct/indirect effects discussion). As modeled under the FMP, the age 2-10+ biomass of GOA pollock is expected to increase (see Section 4.7.1.1). The increase is anticipated primarily because recruitment is expected to improve from recent low levels.

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

- **Reasonably Foreseeable Future External Effects.** As described in FMP 3.1, effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. Marine pollution is identified as having a potential adverse contribution to change in biomass, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified; and the effects 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, the stock is expected to be above MSST for the years 2003-2007 (see direct/indirect effects discussion). Therefore, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, the State of Alaska pollock fisheries, and the State of Alaska shrimp fishery and marine pollution are identified as potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration; and the effects are considered to be 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 FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see Section 4.7.1.1). However, it is determined that the FMP would have insignificant effects on pollock prey availability.

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, climate changes and regime shifts could have potentially adverse or beneficial effects on pollock prey species. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in Table 4.5-2 are determined to be potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under FMP 3.2; and the effects 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.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the FMPs would have insignificant effects on pollock habitat suitability.

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

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

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; and 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.

4.7.1.2 Pacific Cod

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA Pacific cod for each of the bookends under Alternative 3. The goal of Alternative 3 is seek to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and where appropriate and practicable, increased habitat protection and additional bycatch constraints.

Direct/Indirect Effects of FMP 3.1

<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.4-3 of Appendix H. Under FMP 3.1, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,124,000 mt in 2007, with a 2003-2007 average value of 2,089,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 3.1, model projections indicate that total GOA biomass is expected to increase steadily to a value of 675,000 mt in 2007, with a 2003-2007 average value of 622,000 mt.

<u>Spawning Biomass</u>

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H. Under FMP 3.1, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 447,000 mt in 2006, then decrease to a value of 445,000 mt in 2007, with a 2003-2007 average value of 432,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomass are shown in Table H.4-24 of Appendix H. Under FMP 3.1, 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 of 79,000 mt for the years 2003-2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-3 of Appendix H. Under FMP 3.1, 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 0.271 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 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.4-24 of Appendix H. Under FMP 3.1, 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 of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Certain areas that are currently open to fishing would be closed under FMP 3.1. If these closures had been in place in 2001, it is estimated that the following proportions of the 2001 Pacific cod catch would have been displaced from each sub-region:

Area:	Bering Sea	Aleutian Islands	Western GOA	Central GOA	Eastern GOA
Proportion of catch displaced:	0.033	0.681	0.202	0.122	0.000

Under FMP 3.1, catches of Pacific cod are projected to increase in both the BSAI and GOA, meaning that the imposition of new closed areas will tend to increase the amount of catch taken from the remaining open areas.

Under FMP 3.1, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under FMP 3.1. 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.4-3 and H.4-24 of Appendix H).

Age and Size Composition

Under FMP 3.1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 3.1, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMP.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 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 FMP.

Summary of Effects of FMP 3.1 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 3.1, both stocks are projected to remain above MSST throughout the period 2003-2007. The biomass of the BSAI stock is projected to be below $B_{40\%}$ in 2003 but above $B_{40\%}$ in 2004-2007, while the biomass of the GOA stock is projected to be below $B_{40\%}$ throughout the period 2003-2007. The biomass of the BSAI stock is expected to show an overall increase during the period 2003-2007 and beyond, while the biomass of the GOA stock is expected to show an overall decrease during the period 2003-2007 and beyond. All catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 3.1 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 3.1 on BSAI or GOA Pacific cod.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 3.1 on fishing mortality and biomass is rated "insignificant," because the projection model indicates that fishing mortality would be less than the OFL and biomass would be above the MSST throughout the period 2003-2007.

Because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on genetic structure under FMP 3.1 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on reproductive success under FMP 3.1 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of groundfish harvest under FMP 3.1 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of habitat disturbance under

FMP 3.1 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks (Table 4.7-1).

Cumulative Effects of FMP 3.1 – BSAI Pacific Cod

External effects and the resultant cumulative effects associated with FMP 3.1 are depicted in Table 4.5-3 (BSAI cumulative effects). For further information regarding persistent past effects listed below in the text and in the tables, see the past/present effects analysis section of Section 3.5.1.2.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stocks is insignificant under the FMP (see Section 4.7.1.2).

- **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 potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects**. Cumulative effects under FMP 3.1 are identified for mortality of BSAI Pacific cod, and 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 not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stocks is expected to be insignificant under FMP 3.1 (see Section 4.7.1.2).

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

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

- **Cumulative Effects**. Cumulative effects for change in biomass are identified under FMP 3.1; and 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.

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

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

- **Direct/Indirect Effects.** Under FMP 3.1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects 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 the FMP; and 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 FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the FMP 3.1 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 future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown in Table 4.5-3 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

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

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 3.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is rated as insignificant (see Section 4.7.1.2).

- **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 potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under the FMP; 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.

Cumulative Effects of FMP 3.1 – GOA Pacific Cod

Cumulative effects for GOA Pacific cod are summarized in Table 4.5-4.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stocks is insignificant under FMP 3.1 (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod 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 3.5.1.16).

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

- **Cumulative Effects.** A cumulative effect under FMP 3.1 is identified for mortality of GOA Pacific cod, and the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stocks is expected to be insignificant under the FMP 3.1 (see Section 4.7.1.2).

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

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

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

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

- **Direct/Indirect Effects.** Under FMP 3.1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment 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 3.5.1.16).

- **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 the FMP; and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.1 would have insignificant effects on Pacific cod prey availability (see Section 4.7.1.2).

- **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 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for the Bering Sea stock, the effects of climate changes and regime shifts on Pacific cod prey species in the GOA could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in 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 FMP; and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is rated as insignificant (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects identified for GOA 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 3.5.1.16). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** 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 stock , 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 the FMP; 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.

Direct/Indirect Effects of FMP 3.2

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.4-3 of Appendix H. Under FMP 3.2, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,155,000 mt in 2007, with a 2003-2007 average value of 2,105,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 3.2, 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.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H. Under FMP 3.2, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 457,000 mt in 2007, with a 2003-2007 average value of 438,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-24 of Appendix H Under FMP 3.2, 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.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-3 of Appendix H. Under FMP 3.2, model projections indicate that BSAI fishing mortality will increase to a value of 0.277 in 2003, then decrease to a value of 0.249 in 2006, then increase to a value of 0.256 in 2006, then decrease to a value of 0.252 in 2007, with a 2003-2007 average of 0.259. 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.4-24 of Appendix H. Under FMP 3.2, 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 0.280 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

Certain areas that are currently open to fishing would be closed under FMP 3.2. If these closures had been in place in 2001, it is estimated that the following proportions of the 2001 Pacific cod catch would have been displaced from each sub-region:

Area:	Bering Sea	Aleutian Islands	Western GOA	Central GOA	Eastern GOA
Proportion of catch displaced:	0.257	0.477	0.372	0.217	0.560

Under FMP 3.2, catches of Pacific cod are projected to increase in both the BSAI and GOA, meaning that the imposition of new closed areas will tend to increase the amount of catch taken from the remaining open areas.

Under FMP 3.2, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under FMP 3.2. 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.4-3 and H.4-24 of Appendix H).

Age and Size Composition

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

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

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.2 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 FMP.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.2 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.

Summary of Effects of FMP 3.2 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 3.2, both stocks are projected to remain above MSST throughout the period 2003-2007. The biomass of the BSAI stock is projected to be below $B_{40\%}$ in 2003 but above $B_{40\%}$ in 2004-2007, while the biomass of the GOA stock is projected to be below $B_{40\%}$ throughout the period 2003-2007. The biomass of the BSAI stock is expected to show an overall increase during the period 2003-2007 and beyond, while the biomass of the GOA stock is expected to show an overall decrease during the period 2003-2007 but an overall increase farther into the future. All catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 3.2 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 3.2 on BSAI or GOA Pacific cod.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 3.2 on fishing mortality and biomass is rated insignificant, because the projection model indicates that fishing mortality would be less than the OFL and biomass would be above the MSST throughout the period 2003-2007.

Because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on genetic structure under FMP 3.2 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on reproductive success under FMP 3.2 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of groundfish harvest under FMP 3.2 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of habitat disturbance under FMP 3.2 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks (Table 4.7-1).

Cumulative Effects of FMP 3.2

Cumulative effects for BSAI Pacific cod are summarized in Table 4.5-3.

BSAI Pacific Cod

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stocks is insignificant under FMP 3.2 (see Section 4.7.1.2).

- **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.** As described for FMP 3.1 in the BSAI, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** Cumulative effects under FMP 3.2 are identified for mortality of BSAI Pacific cod, and 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 not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stocks is expected to be insignificant under FMP 3.2 (see Section 4.7.1.2).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under FMP 3.2; and 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 FMP 3.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, the IPHC longline and State of Alaska crab fisheries, and subsistence use in the BSAI have the potential to cause adverse effects. Marine pollution could contribute adversely to genetic changes and reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration under the FMP; and 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 FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.2 would have insignificant effects on Pacific cod prey availability (see Section 4.7.1.2).

- **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 FMP 3.1, effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in Table 4.5-3 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.2 would have insignificant effects on Pacific cod habitat suitability (see Section 4.7.1.2).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stocks could be either beneficial or adverse, and marine pollution has also been identified as a potential adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under the FMP; and the effects are 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.

GOA Pacific Cod

Cumulative effects for GOA Pacific cod are summarized in Table 4.5-4.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stocks is insignificant under FMP 3.2 (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod 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 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 in the GOA, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 3.2 is identified for mortality of GOA Pacific cod, and the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stocks is expected to be insignificant under FMP 3.2 (see Section 4.7.1.2).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery and in the State of Alaska groundfish fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass, while climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

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

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

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

- **Direct/Indirect Effects.** Under FMP 3.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, 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. Marine pollution could also contribute adversely to genetic changes and reduced recruitment.

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

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.2 would have insignificant effects on Pacific cod prey availability (see Section 4.7.1.2).

- **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 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 in the GOA, effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in 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 FMP; and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.2 would have insignificant effects on Pacific cod habitat suitability (see Section 4.7.1.2).

- **Persistent Past Effects**. Past effects identified for GOA 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 3.5.1.16). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on GOA Pacific cod stocks could be either beneficial or adverse. Marine pollution has been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

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

4.7.1.3 Sablefish

This section provides the direct, indirect and cumulative effects analysis for sablefish for each of the bookends under Alternative 3. Sablefish are managed as one stock in the BSAI and GOA; therefore, BSAI and GOA areas are discussed together in this section.

The goal of Alternative 3 is seek to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and where appropriate and practicable, increased habitat protection and additional bycatch constraints. For further information regarding persistent past effects listed below in the text and in the table, see the past/present effects analysis section of Sections 3.5.1.3 and 3.5.1.17. Direct/indirect effects are summarized in Table 4.7-1.

Direct/Indirect Effects of FMP 3.1

Catch/ABC

FMP 3.1 is projected to have an insignificant impact on average sablefish yield compared to the baseline. Similar yields are projected because FMP 3.1 assumptions mostly replicate baseline conditions.

Total Biomass

FMP 3.1 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. FMP 3.1 assumptions mostly replicate baseline conditions. Total biomass increases from 2002-2007 under FMP 1 because long-term average recruitment (1977-present) is used to project biomass and is higher than most recent recruitments (Tables H.4-11 and H.4-30 of Appendix H).

Spawning Biomass

FMP 3.1 is projected to have an insignificant impact on spawning biomass compared to the baseline. FMP 3.1 assumptions mostly replicate baseline conditions. Spawning biomass increases from 2002-2007 under FMP1 because long-term average recruitment (1977-present) is used to project biomass and is higher than recent recruitment (Table H.4-11 of BSAI sablefish and H.4-30 of 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 FMP 3.1, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Tables H.4-11 and H.4-30 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 3.1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. FMP 3.1 closed areas are the same as baseline.

Status Determination

Under FMP 3.1, sablefish is not overfished nor approaching an overfished condition.

Age and Size Composition

FMP 3.1 is projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

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

Sex Ratio

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

Habitat Suitability

FMP 3.1 would have no significant effect on habitat suitability compared to the baseline because exploitation rates for FMP1 are similar to baseline.

Predator-Prey Relationships

FMP 3.1 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline, so this FMP should have an insignificant effect on the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish.

Cumulative Effects of FMP 3.1

External effects and the resultant cumulative effects associated with FMP 3.1 are depicted in Table 4.5-5.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 3.1 (see Section 4.7.1.3).

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

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

- **Cumulative Effects**. A cumulative effect under FMP 3.1 is identified for mortality of sablefish, and the effect is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under FMP 3.1 (see direct/indirect effects discussion presented above).

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

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

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

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

- **Direct/Indirect Effects.** Under FMP 3.1 the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects 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 Sections 3.5.1.3 and 3.5.1.17).

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability (see Section 4.7.1.3).

- **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 Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on sablefish prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Sections 3.5.1.3 and 3.5.1.17). Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown in Table 4.5-5 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. FMP 3.1 is not expected to impact habitat compared to baseline. Therefore, it is determined that the FMP would have insignificant effects on sablefish habitat suitability (see 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 Sections 3.5.1.3 and 3.5.1.17). Past fishing for sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries,, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described 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 potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, its effect on the sablefish 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 sablefish stock to sustain itself at or above MSST is jeopardized.

Direct/Indirect Effects of FMP 3.2

Direct/indirect effects are summarized in Table 4.7-1.

Catch/ABC

Alternative 3.2 is projected to significantly decrease sablefish yield compared to the baseline. In Alternative 3.2, a risk-averse adjustment is applied 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 (0.491) is substantial. As a result, projected yield is significantly reduced for Alternative 3.2 (Tables H.4-11 and H.4-30 of Appendix H).

Total Biomass

Alternative 3.2 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.4-11 and H.4-30 of Appendix H).

Spawning Biomass

Alternative 3.2 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.4-11 for BSAI sablefish and Table H.4-30 for GOA sablefish found in Appendix H).

Spawning biomass is projected to remain about the same 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-term projection.

Fishing Mortality

Under Alternative 3.2, 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.4-11 and H.4-30 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. Alternative 3.2 is projected to significantly increase the spatial / temporal concentration of fishing mortality compared to the baseline. The proposed closed areas for this alternative cover some of the areas where the sablefish fishery, both longline and trawl, currently operate, thus restricting 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/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/temporal concentration of fishing effort would inhibit the stock's ability to remain above the MSST.

Status Determination

Under Alternative 3.2, sablefish is not overfished nor approaching an overfished condition.

Age and Size Composition

Alternative 3.2 is projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

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

Sex Ratio

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

Habitat Suitability

Alternative 3.2 would decrease exploitation rates overall, but also will significantly increase the spatial/temporal concentration of fishing mortality compared to the baseline. The proposed closed areas in this alternative cover some longline and trawl fishing for sablefish, thus restricting the fishery to the remaining open areas. This would 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 location and increasing fishing mortality rates on sablefish there. Under Alternative 3.2, 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.

Predator-Prey Relationships

Alternative 3.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline, so this alternative should have an insignificant effect on the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish.

Cumulative Effects of FMP 3.2

Eternal effects and the resultant cumulative effects associated with FMP 3.2 are depicted in Table 4.5-5.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 3.2 (see 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 Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, bycatch and removals of sablefish are predicted to continue in the IPHC longline fishery, and State of Alaska groundfish fishery, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Canadian fisheries within Canadian waters and marine pollution are identified as having a reasonably foreseeable potential adverse contribution. Climate changes and regime shifts are not identified as being contributors to direct sablefish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 3.2 is identified for mortality of sablefish, but the effect is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under FMP 3.2 (see Section 4.7.1.3).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, but climate changes and regime shifts are not identified as being contributors to sablefish mortality, thereby would not directly affect biomass.

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

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

- **Direct/Indirect Effects.** Under FMP 3.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure 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 Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As with FMP 3.1, the IPHC longline and State of Alaska groundfish fisheries, and Canadian fisheries all have the potential to cause adverse effects. Marine pollution could also contribute adversely to genetic changes and reduced recruitment.

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

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability (see Direct/Indirect Effects 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 Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As discussed under FMP 3.1, the effects of climate changes and regime shifts on sablefish prey species could be beneficial or adverse. Marine pollution has been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in Table 4.5-5 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** It is determined that FMP 3.2 would have insignificant effects on sablefish habitat suitability (see 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 Sections 3.5.1.3 and 3.5.1.17). Past fishing for sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** As discussed for FMP 3.1, effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the sablefish stock could be either beneficial or adverse and marine pollution has been identified as a potential adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, its effect on the sablefish 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 sablefish stock to sustain itself at or above MSST is jeopardized.

4.7.1.4 Atka Mackerel

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA Pacific cod for each of the bookends under Alternative 3. The goal of Alternative 3 is to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and where appropriate and practicable, increased habitat protection and additional bycatch constraints. Sections 3.5.1.4 and 3.5.1.18 provide further information regarding persistent past effects listed below in the text and in the tables. Direct/indirect effects are summarized in Table 4.7-1.

Direct/Indirect Effects of FMP 3.1

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 3.1 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.

<u>Catch and Fishing Mortality</u>

The average expected yield for BSAI Atka mackerel for the period 2003-2007 is 62,700 mt (Table H.4-17 of Appendix H). The catch and ABC values, which are nearly equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.436 in 2004, then decrease in 2005 and increase to 0.401 in 2007. Overall, the projections show a 60 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the FMSY proxy ($F_{35\%}$) value of 0.564 which is the rate associated with the OFL.

Projections of GOA Atka mackerel under FMP 3.1 indicate that catches will likely average 400 mt through 2007 (Table H.4-38 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g., Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

<u>Total Biomass</u>

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 3.1, model projections indicate that total BSAI Atka mackerel is expected to decline to a value of 415,000 mt by 2005, then increase to a value of 442,000 mt by 2007, with a 2003-2007 average value of 435,000 mt. Overall, the projections show an 8 percent decrease in total biomass from 2002 to 2007 under FMP 3.1.

Spawning Biomass

Spawning biomass of female BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H. Under FMP 3.1, model projections indicate that BSAI spawning biomass is expected to decline to a value of 78,500 mt by 2005, then increase to a value of 88,000 mt by 2007, with a 2003-2007 average value of 88,900 mt. Overall, the projections show about a 26 percent decrease in female spawning biomass from 2002 to 2007 under FMP 3.1. Projected spawning biomass exceeds the proxy BMSY value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, the current network of spatial/temporal closed areas is in place. The closures designated in the Steller sea lion protection measures probably have the largest impact relative to Atka mackerel.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutians appear to be replenished by immigration and recruitment. In addition, management measures are in place which have the effect of spreading out the harvest in time and space . The overall BSAI TAC is allocated to three management areas (western, central, and Bering Sea/eastern Aleutians). The regional TACs are further allocated to two seasons and there are limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. The temporal/spatial concentration of the catch under FMP 3.1 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 BSAI Atka mackerel are below the OFL in all years under FMP 3.1 (Table H.4-17 of Appendix H). Female spawning biomass in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is not overfished and is determined to be above its MSST under FMP 3.1.

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

Age and Size Composition

Under FMP 3.1, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.74 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term; however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level, therefore, it is unlikely that the age and size compositions would change in the future under FMP 3.1. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than to the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future 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 FMP 3.1, does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST.

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 FMP 3.1. 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 FMP 3.1 will not impact prey availability for BSAI and GOA Atka mackerel.

Summary of Effects of FMP 3.1 – Atka Mackerel

The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis as the model projections yielded results that were deemed either significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overfishing mortality rate (F_{OFL}) and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 3.1. Because the mean projected BSAI Atka mackerel fishing mortality rates are below the overfishing mortality rate, and the spawning stock is above its MSST in each of the projection years (2003-2007), the fishing mortality effect is insignificant for FMP 3.1. As noted above, the spawning stock biomass of BSAI Atka mackerel in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is determined to be above its MSST under FMP 3.1. Therefore, for all other effects, it was determined that FMP 3.1 did not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST, and the effects were insignificant.

Relative to the comparative baseline, under FMP 3.1, the BSAI Atka mackerel stock is not overfished. Spawning biomass declines through 2005, after which biomass increases. Long-term projections (10 and 20 year projections) of spawning biomass show a very stable trend in biomass after 2007, with levels just above the 2007 level of 88,900 mt.

The fishing mortality rate and the MSST for GOA Atka mackerel are unknown; thus the effect of fishing mortality is unknown under FMP 3.1. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration and habitat suitability effects is also unknown under FMP 3.1. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.1 will not impact prey availability for GOA Atka mackerel and the impact to prey availability is insignificant.

Relative to the comparative baseline, under FMP 3.1, the GOA Atka mackerel stock is likely to remain at low abundance under continued low exploitation as a bycatch fishery only.

Cumulative Effects of FMP 3.1 – BSAI Atka Mackerel

External effects and the resultant cumulative effects associated with FMP 3.1 for BSAI Atka mackerel are shown in Table 4.5-6.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 3.1 (see Section 4.7.1.4).

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

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

- **Cumulative Effects.** A cumulative effect under FMP 3.1 is identified for mortality of BSAI Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be insignificant under FMP 3.1 (see Direct/Indirect Effects discussion).

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

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

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

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 FMP 3.1 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 Direct/Indirect Effects discussion).

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

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.1 will have an insignificant effect on prey availability for BSAI Atka mackerel (see 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 potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Habitat disturbance caused by the fishery under FMP 3.1, does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST, and the effect is judged insignificant (see Direct/Indirect Effects discussion).

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

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

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

Direct/Indirect Effects of FMP 3.2

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 3.2 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. Direct/indirect effects are summarized in Table 4.7-1.

Catch and Fishing Mortality

The average expected yield for BSAI Atka mackerel for the period 2003-2007 is 52,300 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 BSAI Atka mackerel stock in 2002 is 0.251 (Table H.4-17 of Appendix H). Model projections show this value will increase to 0.310 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 FMSY proxy ($F_{35\%}$) value of 0.564 which is the rate associated with the OFL.

Projections of GOA Atka mackerel under FMP 3.2 indicate that catches will likely average 200 mt through 2007 (Table H.4-38 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g., Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

Total Biomass

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 3.2, model projections indicate that total BSAI 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 FMP 3.2.

Spawning Biomass

Spawning biomass of female BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H. Under FMP 3.2, model projections indicate that BSAI spawning biomass is expected to decline to a value of 93,800 mt by 2005, then increase to a value of 100,800 mt by 2007, with a 2003-2007 average value of 101,900 mt. Overall, the projections show a 15 percent decrease in spawning biomass from 2002 to 2007 under FMP 3.2. Projected spawning biomass exceeds the B_{MSY} proxy value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.2, 20 percent of the EEZ is designated as marine protected areas (MPA). The MPAs are comprised of no take marine reserves (3 percent of EEZ), and no bottom contact areas (17 percent of EEZ). The spatial closures in the Aleutian Islands under FMP 3.2 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 FMP 3.2, 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 FMP 3.2. 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 FMP. However, FMP 3.2 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 BSAI Atka mackerel are below the OFL in all years under FMP 3.2 (Table H.4-17 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 BSAI Atka mackerel stock is not overfished and is determined to be above its MSST under FMP 3.2.

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

Age and Size Composition

Under FMP 3.2, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.85 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term; however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level, therefore, it is unlikely that the age and size compositions would change in the future under FMP 3.2. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than to the effects of fishing.

Sex Ratio

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

Habitat Suitability

The spatial closures in the Aleutian Islands under FMP 3.2 would eliminate some Atka mackerel fishery areas while increasing effort in the fewer remaining open areas. The level of habitat disturbance would decrease in the closed areas, but increase in the remaining open areas. However, FMP 3.2 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.

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 FMP 3.2, 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 FMP 3.2 will not impact prey availability for BSAI and GOA Atka mackerel.

Summary of Effects of FMP 3.2 – Atka Mackerel

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

The ratings use the overfishing mortality rate (F_{OFL}) and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 3.2. Because the mean projected BSAI Atka mackerel fishing mortality rates are below the overfishing mortality rate, and the spawning stock is above its MSST in each of the projection years (2003-2007), the fishing mortality effect is insignificant for FMP 3.2. As noted above, the spawning stock biomass of BSAI Atka mackerel in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is determined to be above its MSST under FMP 3.2. Therefore, for all other effects, it was determined that FMP 3.2 did not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST, and the effects were insignificant .

Relative to the comparative baseline, under FMP 3.2, the BSAI Atka mackerel stock is not overfished. Projected spawning biomass declines through 2005, after which biomass increases. Long-term projections (10 and 20 year projections) of spawning biomass show a fairly stable trend in biomass after 2007, with levels just above the 2007 level of 100,800 mt.

The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under FMP 3.2. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration and habitat suitability effects is also unknown under FMP 3.2. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.2 will not impact prey availability for GOA Atka mackerel and the impact to prey availability is insignificant.

Relative to the comparative baseline, under FMP 3.2, the GOA Atka mackerel stock is likely to remain at low abundance under continued low exploitation as a bycatch fishery only.

Cumulative Effects of FMP 3.2

Cumulative effects for BSAI Atka mackerel are summarized in Table 4.5-6.

BSAI Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 3.2 (see Direct/Indirect Effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population.

- **Cumulative Effects.** A cumulative effect under FMP 3.2 is identified for mortality of BSAI Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be insignificant under FMP 3.2 (see 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.** As discussed under FMP 3.1, marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

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

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

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

- **Direct/Indirect Effects.** FMP 3.2 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 and the effect is judged to be insignificant (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** As described for FMP 3.1, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. 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.** As described for FMP 3.1, marine pollution could contribute adversely to genetic changes and reduced recruitment, and climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success.

- **Cumulative Effects.** A cumulative effect is 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 FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the internal effect is judged insignificant (see 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 potential beneficial or potential adverse effects on Atka mackerel reproductive success. Marine pollution has been identified as a reasonably foreseeable future adverse contributing factor.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** The reduction of the fishery under this FMP may lead to habitat improvement, but the effect on the stock's ability to maintain itself above its MSST is judged insignificant (see Direct/Indirect Effects discussion).

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

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor.

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

Cumulative Effects of FMP 3.1 and FMP 3.2 – GOA Atka mackerel

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

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under FMP 3.1 and FMP 3.2. The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under FMP 3.1.

- **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, JV, and domestic fisheries, have had a lingering effect on the GOA Atka mackerel population that has not yet recovered (see Section 3.5.1.18).

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

- **Cumulative Effects.** A cumulative effect under FMP 3.1and FMP 3.2 is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Atka mackerel stock is unknown FMP 3.1 and FMP 3.2. 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 likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, JV, and domestic fisheries, have had a lingering effect on the GOA Atka mackerel population that has not yet recovered (see Section 3.5.1.18).

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

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

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

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration effects is also unknown under FMP 3.1 and FMP 3.2.

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

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.1and FMP 3.2 will not impact prey availability for GOA Atka mackerel and the impact to prey availability is determined to be insignificant.

- **Persistent Past Effects.** While lingering population level effects on the invertebrate prey of Atka mackerel from past foreign, state, and domestic fisheries, 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 3.5.1.18).

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the habitat suitability effects is also unknown under FMP 3.1 and FMP 3.2.

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

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from 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 potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

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

4.7.1.5 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 BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species by the National Standard Guidelines.

Eight flatfish species inhabit shallow waters and are managed in the shallow water flatfish assemblage in the GOA. They include: northern and southern rock sole, yellowfin sole, starry flounder, butter sole, English sole, Alaska plaice and sand sole. Survey results from 2001 indicate that over half of the estimated biomass (54 percent) of this assemblage are northern and southern rock sole. The shallow water group is managed as Tier 4 and Tier 5 species in the GOA (Turnock *et al.* 2001). For further information regarding persistent past effects listed below in the text, see the past/present effects analysis section of Section 3.5.1.19.

BSAI Yellowfin Sole – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of yellowfin sole at the start of 2002 is estimated to be 1,552,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 3.1, model projections indicate that the total BSAI biomass is expected to decline to 1,530,000 in 2005 and then increase to 1,538,000 in 2007, an abundance level slightly less than one percent of the 2002 value. The 2003-2007 average total biomass is 1,536,000 mt. Under FMP 3.2, model projections indicate that the total BSAI biomass is expected to decline to 1,420,000 in 2007, an abundance level nearly 9 percent less than the 2002 value. The 2003-2007 average value is 1,467,000 mt.

Spawning Biomass

Spawning biomass of female yellowfin sole at the start of 2002 is estimated to be 450,700 mt. Model projections of future yellowfin sole spawning biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 3.1, model projections indicate that female spawning biomass is expected to decline over 7 percent of the 2002 value to 417,500 mt by 2007, with a 2003-2007 average value of 436,500 mt. Under FMP 3.2, model projections indicate that female spawning biomass is expected to decline 19 percent of the 2002 value to 364,500 mt by 2007, with a 2003-2007 average value of 402,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the 5 year projection under both FMP 3.1 and FMP 3.2.

Fishing Mortality

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Under FMP 3.1, model projections show this value will steadily increase to 0.091 in 2007. Under FMP 3.2, model projections show this value will increase to 0.115 in 2003-2005 and decrease to 0.109 in 2007. These values are well below the F_{MSY} proxy value of 0.138, the rate associated with the OFL (Table H.4-4 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would be affected under FMP 3.1 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.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery. It is estimated that 5 percent of the catch allowed under this FMP would be redistributed relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of BSAI yellowfin sole are below the OFLs in all years under FMP 3.1 and FMP 3.2. The yellowfin sole stock is above the MSST level in 2002.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.3 years. Under FMP 3.2, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.1 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.0 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of yellowfin sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Yellowfin Sole

Table 4.5-8 summarizes the effects of FMP 3.1 and FMP 3.2 on BSAI yellowfin sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis as the model projections yielded results that were determined either significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize FOFL and the MSST as a basis for beneficial or adverse impacts of fishing mortality and change in reproductive success for each FMP. A thorough description of the rationale for the MSST can be found in the National Standard Guidelines 50 CFR Part 600 (FR Vol. 63, No. 84, 24212-24237). Under FMP 3.1 and FMP 3.2, the spawning stock biomass of BSAI yellowfin sole is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the stock is expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.7-1).

Relative to the 2002 comparative baseline, the yellowfin sole stock is projected to continue to not be overfished under these FMPs. Under FMP 3.1, the 20 year projection indicates that the female spawning stock is expected to decline until 2010 to B_{ABC} abundance levels and will increase thereafter through the end of the projection in 2023. Under FMP 3.2, the 20 year projection indicates that the female spawning stock is expected to decline until 2010 to an abundance level higher than B_{MSY} levels and will increase thereafter through the end of the projection to B_{ABC}.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI yellowfin sole are summarized in Table 4.5-8.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI yellowfin sole is rated as insignificant under FMP 3.1 and FMP 3.2 (see Direct/Indirect Effects discussion). The annual fishing mortality values are below the F_{MSY} proxy value of 0.138. Therefore, FMP 3.1 and FMP 3.2 are likely to result in insignificant impacts to these stocks.

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

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

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI yellowfin sole, and 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.** It is expected that FMP 3.1 or FMP 3.2 will result in insignificant impacts to these stocks (see Direct/Indirect Effects discussion).

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

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

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

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see 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 potential beneficial or adverse. Marine pollution has also been identified as having a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI yellowfin sole.

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI yellowfin sole is ranked as insignificant (see Direct/Indirect Effects discussion).

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

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI yellowfin sole is ranked as insignificant (see direct/indirect effects discussion).

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

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

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – GOA Shallow Water Flatfish

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.4-27 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to decrease from 4,800 mt in 2003 to 3,500 mt in 2007. The 2003-2007 average value is 4,200 mt. Under FMP 3.2, model projections indicate that the catch is expected to decrease to 4,100 mt in 2004 and then further decrease to 2,900 mt in 2007. The 2003-2007 average is 3,500 mt.

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 FMP 3.1 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.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery. It is estimated that under this FMP, the catch of Alaska plaice and butter sole would be mostly displaced from the western area (84 percent and 100 percent, respectively) but less in the central area (29 percent and 7 percent) relative to the 2001 catch distribution.

Status Determination

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

Age and Size Composition

Age and size composition projections are not available for 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 FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Shallow Water Flatfish

With the exception of the direct/indirect effects of mortality, the direct and indirect effects of FMP 3.1 and FMP 3.2 on GOA shallow water flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the 5 year projection under these FMPs. The predicted catches are well below the OFL for this stocks, therefore, the effects of FMP 3.1 and FMP 3.2 on shallow water flatfish through mortality is insignificant (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects of GOA shallow water flatfish are summarized in Table 4.5-9.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under FMP 3.1 and FMP 3.2 (see Direct/Indirect Effects discussion).

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

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

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

Change in Biomass

- **Direct/Indirect Effects.** Since the total and spawning biomass estimates for GOA shallow water species is unavailable, the effects of FMP 3.1 and FMP 3.2 on change in biomass is unknown (see Direct/Indirect Effects discussion).

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

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

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

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

- **Direct/Indirect Effects.** It is unknown how the spatial/temporal distribution of the annual GOA shallow water flatfish harvest will be affected under FMP 3.1 and FMP 3.2 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 potential adverse contribution, and the State of Alaska scallop fishery has been identified as a non-contributing factor.

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA shallow water flatfish is determined to be unknown (see Direct/Indirect Effects discussion).

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

- **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 potential adverse contribution, and the State of Alaska scallop fishery is identified as a non-contributing factor.

- **Cumulative Effects.** Cumulative effects for change in prey availability are unknown. The predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be unknown (see 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 3.5.1.19 and 3.6.

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

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

4.7.1.6 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 FMP 3.1 and FMP 3.2

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.4-7 of Appendix H. Under FMP 3.1, model projections indicate that the total BSAI biomass is expected to decline to 706,000 mt by 2007, an abundance level 27 percent less than the 2002 value. The 2003-2007 average total biomass is 778,000 mt. Under FMP 3.2, model projections indicate that the total BSAI biomass is expected to decline to 755,000 in 2007, an abundance level 25 percent less than the 2002 value. The 2003-2007 average value is 791,000 mt.

Spawning Biomass

Spawning biomass of female rock sole at the start of 2002 is estimated to be 331,000 mt. Model projections of future rock sole spawning biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 3.1, model projections indicate that female spawning biomass is expected to decline 47 percent of the 2002 value to 161,300 mt by 2007, with a 2003-2007 average value of 244,100 mt. Under FMP 3.2, model projections indicate that female spawning biomass is expected to decline 41 percent of the 2002 value to 195,100 mt by 2007, with a 2003-2007 average value of 249,600 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the 5 year projection under FMP 3.1 and FMP 3.2.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.064. Under FMP 3.1, model projections show this value will steadily increase to 0.107 in 2007. Under FMP 3.2, model projections show this value will steadily increase to 0.099 by 2007. These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL (Table H.4-7 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI rock sole harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP or what the effect of hot-spot management of PSC would have on fishing behavior.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Fishing would be restricted to previous areas so it is unlikely that fishing effort would become more diffuse over the Bering Sea shelf. It is estimated that 24 percent of the catch would be spatially displaced under this FMP relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of BSAI rock sole are below the OFLs in all years under FMP 3.1 and FMP 3.2 and the female spawning stock size is below the MSST. The rock sole stock is above the MSST level in 2002.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.8 years. Under FMP 3.2, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.9 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of rock sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 or FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 or FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1and FMP 3.2 – BSAI Rock Sole

Under FMP 3.1 and FMP 3.2, the spawning stock biomass of BSAI rock sole is expected to be above the MSST through 2007. Since the fishing mortality rate does not exceed F_{OFL} and the spawning stock size is currently above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.7-1).

Relative to the 2002 comparative baseline, the rock sole stock is projected to continue to not be overfished under these FMPs. Under FMP 3.1, the 20 year projection indicates that the female spawning stock is expected to decline until 2010. From 2010-2012 the stock will be below B_{MSY} before increasing through the end of the projection to levels above B_{ABC} by 2014. Under FMP 3.2, the 20 year projection indicates that the female spawning stock is expected to decline until 2010 to near B_{ABC} levels and will increase thereafter through the end of the projection in 2023.

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

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

Mortality

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under FMP 3.1 and FMP 3.2.

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

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

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI rock sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonable 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 potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the rock sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.6 and 3.10).

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

Spatial/Temporal Concentration of Catch

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

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

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

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

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

Change in Prey Availability

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

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

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

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

Change in Habitat Suitability

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

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

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

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

4.7.1.7 Flathead Sole

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

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

Total biomass of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 3.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 492,000 mt in 2006, then increase to 503,000 mt in 2008, with a 2003-2008 average value of 499,000 mt. Under FMP 3.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 491,000 mt in 2006, then increase to 504,000 mt in 2008, with an average of 499,000 mt from 2003-2008.

Spawning Biomass

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 231,200 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 3.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 168,300 mt in 2008, with a 2003-2008 average value of 197,300 mt. Under FMP 3.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 169,100 mt in 2008, with a 2003-2008 average value of 197,300 mt.

Fishing Mortality

The projected fishing mortality imposed on the BSAI flathead sole stock is 0.045 in 2003, increasing to 0.072 in 2008, with an average from 2003-2008 of 0.055 under FMP 3.1. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 81 percent in 2003 and decreases to 73 percent in 2008, with an average of 78 percent from 2003-2008 (Table H.4-8 of Appendix H).

Under FMP 3.2, the projected fishing mortality imposed on the BSAI flathead sole stock is approximately 0.047 in 2003, increasing to 0.053 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 80 percent in 2003 and decreases to 76 percent in 2008, with an average of 78 percent from 2003-2008 (Table H.4-8 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, a projected average of 11,540 mt of BSAI flathead sole are caught annually from 2003 to 2008, with 3,250 mt (28 percent) of the harvest occurring in the EBS shelf Pacific cod fishery, 2,720 mt (24 percent) of the harvest occurring in the walleye pollock fishery, and 2,420 mt (21 percent) of the harvest occurring in the yellowfin sole fishery. The directed flathead sole fishery contributes only 1,200 mt (10 percent).

The average annual projected harvest of flathead sole under FMP 3.2 was 11,100 mt, of which the yellowfin sole fishery (3,400 mt, 31 percent), Pacific cod (2,900 mt, 26 percent), and walleye pollock (2,500 mt, 23 percent) contribute most of the harvest. The directed flathead sole fishery contributes an average annual harvest of 1,100 mt, or 10 percent. It is estimated that 16 percent of the catch under this FMP will be displaced relative to the catch distribution in 2001.

Status Determination

Under FMP 3.1 and FMP 3.2, 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.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-8 of Appendix H), is 4.57 years. Under FMP 3.2, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-8 of Appendix H), is 4.58 years. This compares with a mean age in the equilibrium unfished stock of 5.39 years.

Sex Ratio

The sex ratio of BSAI flathead sole is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Flathead Sole

Because the BSAI flathead sole are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.1 and FMP 3.2 are considered insignificant. Fishing rates are below accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.7-1).

Relative to the 2002 comparative baseline, the flathead sole stock is projected to continue to not be overfished under these FMPs. Under FMP 3.1 and FMP 3.2, the twenty year projection indicates that the female spawning stock expected to decrease until 2009 at which time it will be begin to steadily increase throughout the end of the projection.

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

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

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under FMP 3.1 and FMP 3.2.

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

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

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI flathead sole, 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 potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.7 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI flathead sole, 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 FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

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

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI flathead sole is ranked as insignificant.

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

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

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; 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 FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI flathead sole is ranked as insignificant.

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

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

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

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

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

Fishing Mortality

The catch of GOA flathead sole in 2002 was estimated to be 2,000 mt. Model projections of future catch are shown in Table H.4-28 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to decrease to 1,300 mt in 2004-2007. The 2003-2007 average value is also 1,300 mt (65 percent of the 2002 catch). Under FMP 3.2, model projections indicate that the catch is expected to decrease to 1,300 mt in 2003 and further decrease to 1,100 by 2007. The 2003-2007 average is 1,300 mt (53 percent of the 2002 catch).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA flathead sole harvest would be affected under FMP 3.1 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.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery.

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.

Age and Size Composition

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

Sex Ratio

The sex ratio of flathead sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1and FMP 3.2 – GOA Flathead Sole

The direct and indirect effects of FMP 3.1 and FMP 3.2 on GOA flathead sole cannot be determined from the MSST criteria used for stocks in management category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stock is over the 5 year projection under these FMPs. The predicted catches are well below the OFL for this stock, therefore, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on flathead sole through mortality (Table 4.7-1).

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

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

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under FMP 3.1 and FMP 3.2.

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

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

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA flathead sole, 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 FMP 3.1 and FMP 3.2, the change in biomass level is rated as unknown since MSST is unable to be determined at this time.

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

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

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

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

- **Direct/Indirect Effects.** Under FMP 3.1 the effect of the spatial/temporal concentration of catch is unknown since the MSST is unable to be determined.

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

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

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch; however, this effect is unknown. The spatial/temporal distribution of flathead sole catch is not expected to change significantly. 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 FMP 3.1 and FMP 3.2, the change in prey availability for the GOA flathead sole is unknown.

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

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA flathead sole is unknown.

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

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

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

4.7.1.8 Arrowtooth Flounder

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

BSAI Arrowtooth Flounder – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 3.1, model projections indicate that the total BSAI biomass is expected to decline to 598,000 mt by 2007, an abundance level 26 percent less than the 2002 value. The 2003-2007 average total biomass is 675,000 mt. Under FMP 3.2, model projections indicate that the total BSAI biomass is expected to decline to 605,000 mt in 2007, an abundance level 25 percent less than the 2002 value. The 2003-2007 average value is 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.4-6 of Appendix H. Under FMP 3.1, 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 FMP 3.2, model projections indicate that female spawning biomass is expected to decline 30 percent of the 2002 value to 335,000 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 5 year projection under both FMP 3.1 and FMP 3.2.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015. Under FMP 3.2, model projections show this value will steadily increase to 0.24 in 2007. Under FMP 3.2, model projections show this value will slowly increase to 0.018 by 2007. These values are well below the F_{MSY} proxy value of 0.38, the rate associated with the OFL (Table H.4-6 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 FMP 3.1 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.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery. It is estimated that 12 percent of the Bering Sea will be displaced under this FMP relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of BSAI arrowtooth flounder are below the OFLs in all years under FMP 3.1 and FMP 3.2. The arrowtooth flounder stocks are above the MSST level throughout the 5 year projection, as in the 2002 baseline year.

Age and Size Composition

Under FMP 3.1 and FMP 3.2, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-6 of Appendix H), is 4.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.4 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the BSAI have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Arrowtooth Flounder

Under FMP 3.1 and FMP 3.2, the spawning stock biomass of BSAI arrowtooth flounder is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under FMP 3.1 and FMP 3.2 are considered insignificant (Table 4.7-1).

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

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects of BSAI arrowtooth flounder are summarized in Table 4.7-1.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI arrowtooth flounder is rated as insignificant under FMP 3.1 and FMP 3.2.

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

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

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI arrowtooth flounder, 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.** Total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections indicate that the BSAI arrowtooth flounder are above their respective MSST for all years. Therefore, it is expected that FMP 3.1 and FMP 3.2 will result in insignificant effects to these stocks.

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

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of arrowtooth flounder due to climate changes and regime shifts are potential beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI arrowtooth flounder. The IPHC longline fishery is identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since the removals are not expected to be significant. The State of Alaska herring fishery is also identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since bycatch is not expected in this fishery.

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI arrowtooth flounder is ranked as insignificant. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 and FMP 3.2; however, since the diet of arrowtooth flounder consists of many species, it is unlikely that the groundfish fisheries would sufficiently change the prey availability such that is jeopardizes the ability of the stock to sustain itself above the MSST.

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

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI arrowtooth flounder is ranked as insignificant. Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.1 and FMP 3.2 would have insignificant effects on arrowtooth flounder habitat suitability.

- **Persistent Past Effects.** Past effects identified for BSAI arrowtooth flounder include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.8.

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

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

GOA Arrowtooth Flounder – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of GOA arrowtooth flounder at the start of 2002 is estimated to be 1,816,000 mt. Model projections of future total GOA biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 3.1, model projections indicate that the total GOA biomass is expected to increase to 2,085,000 mt by 2007, an abundance level 15 percent more than the 2002 value. The 2003-2007 average total biomass is 1,981,000 mt. Under FMP 3.2, model projections indicate that the total GOA biomass is expected to increase to 2,096,000 in 2007, an abundance level 15 percent more than the 2002 value. The 2003-2007 average value is 1,987,000 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.4-29 of Appendix H. Under FMP 3.1, model projections indicate that female spawning biomass is expected to increase 4 percent of the 2002 value to 1,154,900 mt by 2007, with a 2003-2007 average value of 1,142,000 mt. Under FMP 3.2, model projections indicate that female spawning biomass is expected to increase 4 percent of the 2002 value to 1,163,000 mt by 2007, with a 2003-2007 average value of 1,146,000 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the 5 year projection under FMP 3.1 and FMP 3.2.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017. Under FMP 3.1, model projections show this value will be 0.011 in 2007, and 0.01 thereafter. Under FMP 3.2, model projections show this value will be 0.008 the first three years of the projection and 0.007 in 2006 and 2007. These values are well below the F_{MSY} proxy value of 0.165, the rate associated with the OFL (Table H.4-29 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 FMP 3.1 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.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery. It is estimated that 25 percent and 29 percent of the GOA western region and GOA central region catch, respectively, will be displaced under this FMP relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of GOA arrowtooth flounder are below the OFLs in all years under FMP 3.1 and FMP 3.2. The arrowtooth flounder stocks are above the MSST level throughout the 5 year projection, as in the 2002 baseline year.

Age and Size Composition

Under FMP 3.1 and FMP 3.2, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-29 of Appendix H), is 5.0 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.1 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the GOA have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Arrowtooth Flounder

Under FMP 3.1 and FMP 3.2, the spawning stock biomass of GOA arrowtooth flounder is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime (Table 4.7-1).

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

Cumulative Effects of FMP 3.1 and FMP 3.2

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

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA arrowtooth flounder is rated as insignificant under FMP 3.1 and FMP 3.2.

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

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

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

Change in Biomass Level

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

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

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

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 are the same as those described for BSAI arrowtooth flounder under this FMP.

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 3.5.1.21).

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 this FMP.

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

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

4.7.1.9 Greenland Turbot and Deepwater Flatfish

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

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 3.1, 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 FMP 3.2, model projections indicate that the total BSAI biomass is expected to decline to 103,000 in 2007, an abundance level 2.5 percent less than the 2002 value. The 2003-2007 average value is 101,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 3.1, 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. 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.

Under FMP 3.2, model projections indicate that female spawning biomass is expected to decline 10 percent of the 2002 value to 61,100 mt by 2007, with a 2003-2007 average value of 62,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,600 mt throughout the 5 year projection.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Under FMP 3.1, model projections show this value will increase to 0.19 in 2004 before decreasing to 0.162 in 2007.

Under FMP 3.2, model projections indicate this value will steadily increase to 0.066 by 2007. These values are well below the F_{MSY} proxy value of 0.48, the rate associated with the OFL (Table H.4-5 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would be affected under FMP 3.1 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.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery. It is estimated that 6 percent of the catch would be spatially displaced under this FMP relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of BSAI Greenland turbot are below the OFLs in all years under FMP 3.1 and FMP 3.2. The Greenland turbot female spawning stock is above the MSST level in all 5 years of the projection, as in the baseline year 2002.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.6 years. Under FMP 3.2, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.9 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 and FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Greenland Turbot

Under FMP 3.1 and FMP 3.2, the spawning stock biomass of BSAI Greenland turbot is expected to be above the MSST. The stock is currently above the MSST and the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under FMP 3.1 and FMP 3.2 are considered insignificant.

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to continue to not be overfished under these FMPs. Under FMP 3.1, the 20 year projection indicates that the female spawning stock is expected to decline until 2007 to less than B_{MSY} levels for two years (2007 and 2008), but will increase thereafter through the end of the projection in 2023. By 2011, it is projected that the female spawning stock biomass will be above B_{ABC}. Under FMP 3.2, the 20 year projection indicates that the female spawning stock is expected to decline until 2007 but will remain above B_{ABC} levels and will increase thereafter through the end of the projection in 2023.

Cumulative Effects of FMP 3.1 and FMP 3.2

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

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 3.1 and FMP 3.2.

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

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is 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 potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the Greenland turbot biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (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.

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

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI Greenland turbot.

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

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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).

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

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

GOA Deepwater Flatfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

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

Fishing Mortality

The catch of GOA deepwater flatfish in 2002 was estimated to be 600 mt. Model projections of future catch are shown in Table H.4-25 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to increase to 1,000 mt in 2005-2007 with a 2003-2007 average value of 1,100 mt. Under FMP 3.2, model projections indicate that the catch is expected to increase to 900 mt in 2004-2007 and the 2003-2007 average is also 900 mt.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA deepwater flatfish harvest would be affected under FMP 3.1 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.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery. It is estimated that the Dover sole catch would be displaced 2 percent in the western area and 23 percent in the central area under this FMP relative to the 2001 catch distribution.

Status Determination

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

Age and Size Composition

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

Sex Ratio

The sex ratio of deepwater flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on deepwater flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Deepwater Flatfish

The direct and indirect effects of FMP 3.1 and FMP 3.2 on GOA deepwater flatfish cannot be determined from the MSST criteria used for stocks in management category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the 5 year projection under these FMPs. The predicted catches under FMP 3.1 and FMP 3.2 are well below the OFL for this stock, therefore the direct/indirect effects of mortality on GOA deepwater flatfish are considered insignificant (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

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

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deepwater flatfish is rated as insignificant under FMP 3.1 and FMP 3.2.

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

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

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA deepwater 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 Level

- **Direct/Indirect Effects.** Total and spawning biomass estimates are unavailable for the deepwater flatfish species, therefore, the effects of FMP 3.1 and FMP 3.2 on the change in biomass level are unknown.

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

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

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown for the stock since the MSST is unable to be determined.

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

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

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA deepwater flatfish complex is unknown.

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

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

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA deepwater flatfish complex is unknown.

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

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

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

4.7.1.10 Alaska Plaice and Other Flatfish and Rex Sole

BSAI Alaska plaice and other flatfish and GOA rex sole are described in more detail in Sections 3.5.1.10 and 3.5.1.23 of this Programmatic SEIS.

BSAI Alaska Plaice – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

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.4-9 of Appendix H. Under FMP 3.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,124,000 mt in 2008, with a 2003-2008 average value of 1,105,000 mt. Under FMP 3.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,119,000 mt in 2008, with a 2003-2008 average value of 1,100,000 mt.

Spawning Biomass

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 276,000 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-9 of Appendix H. Under FMP 3.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 284,700 mt in 2008, with a 2003-2008 average value of 279,400 mt.

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 275,500 mt. Under FMP 3.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 282,300 mt in 2008, with a 2003-2008 average value of 277,200 mt.

Fishing Mortality

Under FMP 3.1, the projected fishing mortality imposed on the BSAI Alaska plaice stock is 0.017 in 2003, decreasing to 0.016 in 2005, and increasing 0.019 in 2008, with an average from 2003-2008 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 2008, with an average of 92 percent from 2003-2008 (Table H.4-9 of Appendix H).

Under FMP 3.2, the projected fishing mortality imposed on the BSAI Alaska plaice stock is approximately 0.023 in 2003, declining to 0.018 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 89 percent in 2003 and increases to 92 percent in 2008, with an average of 91 percent from 2003-2008 (Table H.4-9 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, a projected average of 9,740 mt of BSAI Alaska plaice are caught annually from 2003 to 2008, with 7,100 mt (73 percent) of the harvest occurring in the EBS shelf yellowfin sole fishery.

The average annual projected harvest of Alaska plaice under FMP 3.2 was 11,200 mt, with 9,500 mt (85 percent) of the harvest occurring in the EBS shelf yellowfin sole fishery. It is estimated that 12 percent of the catch under this FMP will be displaced relative to the 2001 catch distribution due to area closures.

Status Determination

Under FMP 3.1 and FMP 3.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below ABC and OFL levels from 2003 to 2008.

Age and Size Composition

Under FMP 3.1 and FMP 3.2, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections (Table H.4-9 of Appendix H), is 4.40 years. This compares with a mean age in the equilibrium unfished stock of 4.51 years.

Sex Ratio

The sex ratio of BSAI Alaska plaice is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Alaska Plaice

Because the BSAI Alaska plaice are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.1 and FMP 3.2 are considered insignificant. Fishing rates are below accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.7-1).

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

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI Alaska plaice are summarized in Table 4.5-17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Alaska plaice stock is insignificant under FMP 3.1 and FMP 3.2.

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

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

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, 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 FMP 3.1 and FMP 3.2.

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

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

- **Cumulative Effects.** A cumulative effect is identified for BSAI Alaska plaice change in biomass 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.** FMP 3.1 and FMP 3.2 would have an insignificant effects on BSAI Alaska plaice spatial/temporal characteristics.

- **Persistent Past Effects.** No persistent past effects have been identified for the genetic structure of the BSAI Alaska plaice population. Although, climate changes and regime shifts have been identified as having a potential beneficial or adverse effect on BSAI Alaska plaice reproductive success. 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 potential adverse contribution to BSAI Alaska plaice genetic structure and reproductive success. Acute and/or chronic events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and could also result in reduced recruitment. Climate changes and regime shifts have been identified as potential beneficial or adverse contributors to the reproductive success of BSAI Alaska plaice, but as non-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/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.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effects on BSAI Alaska plaice prey availability.

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

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

- **Cumulative Effects.** A cumulative effect has been identified for the BSAI Alaska plaice change in prey availability 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.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effects on Alaska plaice habitat suitability.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries have been identified as having adverse effects on BSAI Alaska plaice habitat. See Sections 3.5.1.10 and 3.6 for more information on the effects of fishing gear on flatfish habitat. Climate changes and regime shifts are also identified as having a potential adverse or beneficial effect on Alaska plaice habitat (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to BSAI Alaska plaice habitat suitability. Acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success of Alaska plaice. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions to BSAI Alaska plaice habitat suitability. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment is favored.

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

BSAI Other Flatfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

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.4-10 of Appendix H. Under FMP 3.1, 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 2,100 mt. Under FMP 3.2, model projections indicate that the catch is expected to decrease from the 2002 value to 2,200 mt in 2003 and then further decline to 1,900 mt in 2007 (26 percent decrease from 2002). The 2003-2007 average catch is 2,000 mt.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI other flatfish harvest would be affected under FMP 3.1 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.

It is unknown what goals, objectives, and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery.

Status Determination

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

Age and Size Composition

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

Sex Ratio

The sex ratios 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 FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Other Flatfish

The direct and indirect effects of FMP 3.1 and FMP 3.2 on BSAI other flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five-year projection under these FMPs. The predicted catches of BSAI other flatfish under FMP 3.1 and FMP 3.2 are well below the OFL for this stock. Therefore, the effects of FMP 3.1 and FMP 3.2 on BSAI other flatfish through mortality are considered insignificant (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI other flatfish are summarized in Table 4.5-18.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have not been identified for BSAI other flatfish mortality.

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

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

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 these FMPs.

- **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 FMP 3.1 and FMP 3.2, 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 these FMPs.

- **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 FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other flatfish catch; however, this effect is unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 these FMPs.

- **Reasonably Foreseeable Future External Effects**. The effects on change in prey availability are the same as those described for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for habitat suitability are the same as those described for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for BSAI other flatfish habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

GOA Rex Sole – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

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.4-26 of Appendix H. Under FMP 3.1, 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 FMP 3.2, model projections indicate that the catch is expected to increase to 3,100 mt in 2003-2006 and then decrease to 3,000 mt in 2007. The 2003-2007 average is 3,100 mt.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA rex sole harvest would be affected under FMP 3.1 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.

It is unknown what goals, objectives, and criteria would be developed under FMP 3.2 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 that the baseline 2002 fishery. It is estimated that 51 percent of the catch in the western area would be displaced under this FMP and 38 percent in the central area relative to the 2001 catch distribution.

Status Determination

The available information for GOA rex sole requires that they are classified into the Tier 5 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status.

Age and Size Composition

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

Sex Ratio

The sex ratio of rex sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 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.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Rex Sole

The direct and indirect effects of FMP 3.1 and FMP 3.2 on GOA rex sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stock is over the five-year projection under these FMPs. The predicted catches of rex sole are well below the OFL for this stock. Therefore, FMP 3.1 and FMP 3.2 have insignificant effects on GOA rex sole through mortality (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for GOA rex sole are summarized in Table 4.5-19.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on GOA rex sole stocks. See Section 3.5.1.23 for details regarding these effects.

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

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

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 an adverse persistent past effect on GOA rex sole stocks. See Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potential beneficial or adverse effect on the rex sole biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. The State of Alaska Scallop Fishery is identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole. For more information on climate changes and regime shifts (see Sections 3.5.1.23 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA rex sole, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 3.5.1.23 and 3.10 for more information of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the genetic structure of rex sole include the potential adverse effects of marine pollution since an acute and/or chronic pollution event could alter the genetic structure of the population by causing localized mortality. The State of Alaska scallop fishery and climate changes and regime shifts have both been identified as non-contributing factors to the change in genetic structure of rex sole stocks. These events are not expected to cause localized depletions that would alter the genetic sub-population structure of rex sole stock. Change in reproductive success of rex sole due to climate changes and regime shifts are identified as having a potential beneficial or adverse effect. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could also the reproductive success of GOA rex sole. Again, the State of Alaska scallop fishery has been identified as a non-contributing factor since the scallop fishery is not expected to contribute to rex sole removals.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rex sole catch; however, this effect is unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 effected the prey availability of the GOA rex sole stock. The actual effect of climate changes and regime shifts on rex sole prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.23 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects**. Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The State of Alaska scallop fishery has been identified as having a potential adverse effect on rex sole prey availability since the habitat disturbances caused by dredging could influence the availability of benthic prey.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for GOA rex sole include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the GOA rex sole stock See Sections 3.5.1.23 and 3.10 for more information regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as having potential adverse effects on rex sole habitat suitability that may cause changes in the spawning or rearing success of the stock.

- **Cumulative Effects.** A cumulative effect is identified for GOA rex sole habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

4.7.1.11 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 FMP 3.1 and FMP 3.2

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.4-12 of Appendix H. Under FMP 3.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 399,000 mt in 2008, with a 2003-2008 average value of 386,000 mt. Under FMP 3.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 409,000 mt in 2008, with a 2003-2008 average value of 391,000 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.4-12 of Appendix H. Under FMP 3.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 140,200 mt in 2008, with a 2003-2008 average value of 137,200 mt. Under FMP 3.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 144,800 mt in 2008, with a 2003-2008 average value of 139,600 mt.

Fishing Mortality

Under FMP 3.1, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is 0.033 in 2003, decreasing to 0.026 in 2005, and increasing 0.032 in 2008, with an average from 2003-2008 of 0.030 (Table H.4-12 of Appendix H). Under FMP 3.2, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is approximately 0.023 in each year from 2003 to 2008. The proportion of spawner biomass per recruit conserved under this fishing mortality rate is 60 percent (Table H.4-12 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, a projected average of 10,000 mt of BSAI Pacific ocean perch are caught annually from 2003 to 2008, with 4,900 mt (49 percent) 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 1,000 mt annually from 2003-2008.

As with FMP 3.1, the eastern Aleutians Islands contributes the largest proportion of the BSAI Pacific ocean perch catch. The average annual projected catch from 2003-2008 was 7,900 mt, of which 3,600 mt (46 percent) occurred 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 1,000 mt of Pacific ocean perch annually from this region. A series of no-take reserves is also specified under FMP 3.2, but comparison with the recent spatial distribution of the fishery indicates that substantial areas would remain open for Pacific ocean perch fisheries.

Status Determination

Under FMP 3.1, 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 FMP 3.1.

Under FMP 3.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are at the ABC level from 2003 to 2005, and slightly below the ABC level from 2006 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 FMP 3.2.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections, is 10.41 years. Under FMP 3.2, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-12 of Appendix H), is 10.53 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 FMP 3.1 and FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1 and FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 and FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Pacific Ocean Perch

Because the BSAI Pacific ocean perch are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.1 and FMP 3.2 are considered insignificant. A significant feature of FMP 3.2 is the use of the $F_{60\%}$ fishing rate for BSAI Pacific ocean perch, lowering the fishing mortality rate, the ABC, and the projected harvest. Fishing rates are within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.7-1).

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI Pacific ocean perch are summarized in Table 4.5-20.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to BSAI Pacific ocean perch mortality since bycatch in this fishery is not expected. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific ocean perch mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at 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 FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute significantly to BSAI Pacific ocean perch mortality since bycatch is not expected in this fishery. Therefore, the IPHC longline fishery is also not expected to cause significant changes in biomass levels. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to Pacific ocean perch change in biomass levels as a function of reproductive success.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific ocean perch population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure . However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.11) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery are not expected to contribute to changes in genetic structure or reproductive success of BSAI Pacific ocean perch since bycatch of BSAI Pacific ocean perch is not expected to occur. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. Generally, changes in climate changes that lead to increased advection of the Alaska current are believed to increase euphausiid production, a major prey item of BSAI Pacific ocean perch. Climate changes and regime shifts are not considered to contribute to changes in genetic structure.

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

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific ocean perch prey species (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific ocean perch prey species are identified as potential beneficial or adverse contributors. In general, it is believed that climate changes and regime shifts that lead to the increased advection of the Alaska current also increase production of euphausiids, a major prey item of BSAI Pacific ocean perch. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect 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.** FMP 3.1 and FMP 3.2 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for BSAI Pacific ocean perch stocks include past foreign, JV, and domestic fisheries, IPHC longline fisheries and climate changes and regime shifts (see Section 3.5.1.11). Intense bottom trawling on Pacific ocean perch habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries are also identified as having adverse effects on Pacific ocean perch habitat, although these fishing gear impacts are considered to be less significant than those associated with trawl gear (see Section 3.6 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both beneficial and adverse effects on Pacific ocean perch habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is identified as making adverse contributions to Pacific ocean perch habitat through fishing gear impacts. As stated above, these impacts are expected to be of lesser magnitude than those effects associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific ocean perch stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect 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.

GOA Pacific Ocean Perch – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass and Fishing Mortality

Under FMP 3.1 the PSC limits for Pacific halibut are reduced by ten percent. If 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 reduce catch of GOA Pacific ocean perch as well. Bycatch model results for FMP 3.1 show catches comparable to FMP 1 for GOA Pacific ocean perch and therefore appear reasonable. Average fishing mortality during the years 2003-2008 is expected to be less than F_{OFL} (0.060) (Table H.4-36 of Appendix H).

FMP 3.2 would reduce catch of GOA Pacific ocean perch because it changes the biological reference point for determining rockfish ABCs from $F_{40\%}$ to $F_{60\%}$. Under FMP 3.2 the PSC limits for Pacific halibut are also reduced by 30 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 reduce catch of GOA Pacific ocean perch as well. Bycatch model results for FMP 3.2 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.4-36 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effects that FMP 3.1 has on the spatial/temporal concentration of Pacific ocean perch catch depends on the decisions made by the 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 the NPFMC implemented some "rights-based" management scheme. If the Pacific ocean perch trawl fishery has a large bycatch of Pacific halibut, then under FMP 3.1 the spatial/temporal concentration of fishing effort may also be affected by PSC limits on Pacific halibut bycatch.

As with FMP 3.2, the effects that FMP 3.2 has on the spatial/temporal concentration of Pacific ocean perch catch depends on the decisions made by the 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. The implementation of fishery rationalization should also spread the fishery out in time and space. FMP 3.2 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, then 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.

Under FMP 3.2 the spatial/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 FMP 3.1, the projected B2003 of 112,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B2005 of 112,100 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Under FMP3.2, the projected B2003 of 113,500 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B2005 of 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 FMP 3.1 and FMP 3.2, 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.

Sex Ratio

No information is available to suggest that the sex ratio would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Under FMP 3.1 and FMP 3.2, damage to epifauna by bottom trawls may adversely impact juvenile Pacific ocean perch habitat. FMP 3.1 and FMP 3.2 may also beneficially affect habitat for GOA Pacific ocean perch because it maintains the eastern GOA closure to trawling. FMP 3.2 may also have a beneficial effect on the habitat of GOA Pacific ocean perch because it proposes to set aside 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 they could provide additional refugia for Pacific ocean perch in these areas and or provide protection from the potential effects of trawling on juvenile rockfish habitat in these areas.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Pacific Ocean Perch

Under FMP 3.1 and FMP 3.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 3.1 and FMP 3.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability. Section 3.5.1.24 provides further detail on the past/present effects analysis for GOA Pacific ocean perch (Table 4.7-1).

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

Cumulative effects are summarized for GOA Pacific ocean perch in Table 4.5-21.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **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 FMP 3.1 and FMP 3.2.

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

- **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 these FMPs.

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

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

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

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

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 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 these FMPs.

- **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 these FMPs.

- **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.** FMP 3.1 and FMP 3.2 would have insignificant effects on Pacific ocean perch habitat suitability.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect 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.

4.7.1.12 Thornyhead Rockfish

GOA thornyhead rockfish are described in more detail in Section 3.5.1.23 of this Programmatic SEIS. Until recently thornyhead rockfish 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, thornyhead rockfish were modeled under the Tier 3 category for this analysis.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

Total (ages 5 through 55+) biomass of GOA thornyheads at the start of 2002 is estimated to be 54,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-37 of Appendix H. Under FMP 3.1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly increase to a value of 55,000 mt by 2007, with a 2003-2007 average value of 55,000 mt. Under FMP 3.2, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly increase to a value of 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.4-37 of Appendix H. Under FMP 3.1, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and increasing to 24,300 mt by 2007, with a 2002-2007 average value of 23,900 mt. Under FMP 3.2, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2004, and 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 FMP 3.1, fishing mortality is projected to decrease to 0.025 in 2003 and decrease further to 0.020 in 2007. Under FMP 3.2, fishing mortality is projected to decrease to 0.013 in 2003 and decrease further 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.4-37 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 FMP 3.1 or FMP 3.2 that is expected to change this. Longline catches are spatially dispersed along the continental shelf break throughout the GOA (Figure 4.5-1), and temporally dispersed due to the nature of the IFQ sablefish fishery. For example, longline thornyhead catches in 2000 occurred year round, with peaks in April and September which did not exceed 60 mt per week. Trawler catch has been more concentrated in time, with some catches of 20-40 mt per week happening in late spring and a single large peak of 160 mt per week in 2000 during July, coincident with the rockfish trawl fishery. Between 1997 and 1999, trawl thornyhead catches appear to have become more concentrated in space (Figure 4.5-2). The distribution of thornyheads from surveys did not appear to change over the same time period (Figure 4.5-3). This apparent concentration may be the indirect result of changes in the trawl fisheries for deepwater flatfish and rockfish since thornyheads are not a primary target of trawl fisheries. However, it should be noted that the overall catch of thornyheads is low relative to both the estimated biomass and the ABC, such that this apparent concentration of catch is unlikely to have any adverse population effects.

Status Determination

The GOA thornyhead stock is not overfished. At 23,500 mt, spawning stock biomass is expected to be well above both $B_{35\%}$ level (14,681 mt) as well as the $B_{40\%}$ level (16,045 mt) in the year 2002 and will remain above $B_{40\%}$ in all projection years under FMP 3.1 and FMP 3.2.

Age and Size Composition

Under FMP 3.1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.16 years. Under FMP 3.2, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.35 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 FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Under FMP 3.1 and FMP 3.2, all current management measures would be maintained. The level of habitat disturbance under FMP 1 (and FMP 3.1 and FMP 3.2) does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Thornyhead Rockfish

The GOA thornyhead stock appears to be healthy and stable under current management, and catches have generally been below the estimated ABCs because thornyheads are taken as bycatch in other directed fisheries. To the best of our knowledge, thornyheads are widely distributed in the deeper habitats of the GOA, where fishing impacts have historically been low. As long as catches remain at or near the currently observed low levels, as predicted under FMP 3.1 and FMP 3.2, we do not expect any significant population effects to thornyheads (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects are summarized for GOA thornyhead rockfish in Table 4.5-22.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. The removals of thornyhead rockfish that occurred in these fisheries have had a lingering adverse effect on the populations (see Section 3.5.1.23).

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

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

Change in Biomass Level

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 will result in insignificant effects to these stocks.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. Past removals by these fisheries have had a lingering adverse effect on the GOA thornyhead rockfish populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effect son change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the thornyhead rockfish biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.23 and 3.10). The IPHC longline fishery is identified as a potential adverse contributor to the thornyhead rockfish biomass level since they are caught as bycatch in this fishery. The State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA thornyhead rockfish. The IPHC longline fishery removals could be sufficiently concentrated as to alter the genetic structure and reproductive success of GOA thornyhead rockfish populations and is therefore identified as a potential adverse contributor. The State of Alaska shrimp fishery is identified as a non-contributing factor since bycatch of thornyhead rockfish is not expected to occur in this fishery.

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

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA thornyhead rockfish is ranked as insignificant.

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

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor since bycatch of GOA thornyhead rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to prey availability since removal of shrimp, the main prey species of GOA thornyhead rockfish, occurs in this fishery.

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

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery has been identified as a potential adverse contributor to GOA thornyhead rockfish habitat suitability. See Section 3.6 for information on the impacts of fishery gear on EFH. The State of Alaska shrimp fishery is identified as a non-contributing factor since habitat degradation by the shrimp fishery gear is not expected to occur.

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

4.7.1.13 Rockfish

Rockfish are discussed in more detail in Sections 3.5.1.12 through 3.5.1.14 and 3.5.1.24.

BSAI Northern rockfish

Until recently, BSAI northern rockfish were managed as a sub-assemblage of the BSAI other red rockfish group under Tier 5 management category. As of 2004, northern rockfish in the BSAI are managed separated under Tier 3 and the red rockfish group no longer exists. However, for the purposes of this analysis, northern rockfish have been modeled under the Tier 5 category. Direct/indirect effects are summarized in Table 4.7-1.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

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 6,400 mt. Projected catches from 2003-2008 are shown in Table H.4-15 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to decrease to 5,300 mt in 2006, then increase to 5,600 mt in 2008. The 2003-2008 average catch is 5,700 mt. Under FMP 3.2, model projections indicate that the catch is expected to decrease to 4,000 mt in 2006, and remain at this level through 2008. The 2003-2008 average catch is 3,600 mt.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, model projections indicate that the average harvest of 5,700 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (3,100 mt, 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.

Under FMP 3.2, model projections indicate that the average harvest of 3,600 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (1,500 mt, 40 percent), with 1,200 mt (34 percent) occurring in the central Aleutian Islands and 700 mt (20 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.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST cannot be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for this species. The sex ratio of BSAI northern rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Northern Rockfish

An age-structured population model for BSAI northern rockfish is not available, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI northern rockfish are fished at less than the OFL and the effects of mortality under FMP 3.1 are considered insignificant. Since the MSST is unable to be calculated, the spatial/temporal distribution of catch and the other direct/indirect effects are unknown.

A significant feature of FMP 3.2 is the lowering of ABC levels for rockfish. For northern rockfish, the ABC was assumed to be 4,100 mt, a decrease from the baseline value of 9,500 mt in 2002. Because the BSAI northern rockfish are fished at less or equal to the ABC, the effects or mortality under FMP 3.2 are considered insignificant. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity; however, since the MSST is unable to be calculated, the other direct/indirect effects are unknown.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI northern rockfish are summarized in Table 4.5-23.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **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 an adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.12).

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

- **Cumulative Effects.** A cumulative effect identified for mortality of BSAI northern 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 FMP 3.1 and FMP 3.2, 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 an adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.12).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the northern rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.12 and 3.10). The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish species is not expected to occur in this fishery.

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

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI northern rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI northern rockfish (see Sections 3.5.1.12 and Section 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of northern rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI northern rockfish. The IPHC longline fishery has been identified as a non-contributing factor to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the northern rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI northern rockfish stock. The actual effect of climate changes and regime shifts on northern rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect. See Section 3.5.1.12 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of northern rockfish prey species occurs in this fishery. See Section 3.5.1.12 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 FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI northern rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in northern rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on northern rockfish species habitat suitability, possibly having disrupted northern rockfish species spawning and/or rearing habitats. See Section 3.5.1.12 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 potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the northern rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt northern rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the northern rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

BSAI Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

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 800 mt. Projected catches from 2003-2008 are shown in Table H.4-16 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to range between 700 and 800 mt from 2003-2008, with an average of 800 mt. Under FMP 3.2, the projected catch of BSAI shortraker/rougheye rockfish in each year from 2003 to 2008 was 400 mt.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, model projections indicate that the average harvest of 800 mt from 2003-2008 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.

Under FMP 3.2, model projections indicate that the average harvest of 400 mt from 2003-2008 occurs largely in the western and eastern Aleutian Islands, with 36 percent and 33 percent of the harvest occurring in these two areas, respectively. The harvest in these two areas occurs largely in the Pacific ocean perch trawl fishery.

Status Determination

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

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. The sex ratio of BSAI shortraker/rougheye rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 of FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Shortraker/Rougheye Rockfish

An age-structured population model for BSAI shortraker/rougheye rockfish is not available, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI shortraker/rougheye rockfish are fished at less than the ABC and effects of mortality under FMP 3.1 are considered insignificant. Since the MSST cannot be determined, the spatial/temporal distribution of catch and the other direct/indirect effects are unknown.

A significant feature of FMP 3.2 is the lowering of ABC levels for rockfish. For shortraker/rougheye rockfish, the ABC was assumed to be 400 mt. Because the BSAI shortraker/rougheye rockfish are fished at less or equal to the ABC, the effects of mortality under FMP 3.2 are considered insignificant. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity; however, since the MSST is not able to be calculated, the other direct/indirect effects are unknown (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI shortraker/rougheye rockfish are summarized in Table 4.5-24.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **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 an adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

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

- **Cumulative Effects.** A cumulative effect identified for mortality of BSAI shortraker/rougheye 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.

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 an adverse 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 potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.13 and 3.10). The IPHC longline fishery and the State of Alaska shrimp fishery are identified as a non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI shortraker/rougheye rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI shortraker/rougheye rockfish (see Sections 3.5.1.13 and Section 3.10).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the reproductive success of shortraker/ rougheye rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of shortraker/rougheye rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery have been identified as non-contributing factors to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the shortraker/rougheye rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI shortraker/rougheye rockfish stock. The actual effect of climate changes and regime shifts on shortraker/rougheye rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.13 and 3.10 for more information on climate changes and regime shifts.

- **Reasonable Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of shortraker/rougheye rockfish prey species occurs in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to BSAI shortraker/rougheye prey availability since shrimp is on e of the main prey species of rougheye rockfish. See Section 3.5.1.13 for more information on the trophic interactions of BSAI shortraker/rougheye rockfish species.

- **Cumulative Effects.** A cumulative effect identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI shortraker/rougheye rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in shortraker/rougheye rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on shortraker/ rougheye rockfish species habitat suitability, possibly having disrupted shortraker/rougheye rockfish species spawning and/or rearing habitats. The State of Alaska shrimp fishery is identified as a non-contributing factor to shortraker/rougheye rockfish habitat suitability since habitat degradation by shrimp fishery gear is not expected to occur. See Section 3.5.1.13 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 potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the shortraker/rougheye rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt shortraker/rougheye rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, 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.

BSAI Other Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

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

Fishing Mortality

Under FMP 3.1, the projected catch of Aleutian Islands other rockfish in 2003 to 2008 ranged from 200 mt to 300 mt, with and average of 300 mt. The projected harvest of EBS other rockfish from 2003 to 2008 was 100 mt in each year. Projected catches from 2003-2008 are shown in Tables H.4-13 and H.4-14 of Appendix H. 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.

Under FMP 3.2, the projected catch of the Aleutian Islands other rockfish category was 200 mt in 2003 and 100 mt annually from 2004 to 2008. The projected harvest of EBS other rockfish species was estimated at approximately 50 mt in each year from 2003 to 2008. Projected catches from 2003-2008 are shown in Tables H.4-13 and H.4-14 of Appendix H. These projections suggest that direct fishing mortality on other rockfish stocks will be very low relative to the current OFLs and that such harvest levels will not present any significant impact to the species ability to maintain current population levels.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, 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. Under FMP 3.2, in the Aleutian Islands, 89 percent of the average harvest of 130 mt occurs in the cental and western Aleutian Islands, taken largely in the Atka mackerel and Pacific cod trawl fisheries. In the EBS, the average catch of 50 mt is taken largely in the Pacific cod and pollock trawl fisheries. We would expect no significant change in the spatial/temporal concentration of catch as a result of reduced other rockfish TACs.

Status Determination

The fishing mortality rate is below the ABC and OFL for all years. The MSST is unable to be determined.

Age and Size Composition and Sex Ratio

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

Habitat-Mediated Impacts

Any habitat-related impacts of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat suitability impacts, any effect on predator-prey relationships of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Other Rockfish

An age-structured population model for either the EBS or Aleutian Islands other rockfish category is not available, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI other rockfish are fished at less than the ABC and the direct and indirect effects under FMP 3.1 are considered either insignificant through mortality. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity; however, since the MSST is unable to be calculated, the other direct/indirect effects are unknown.

A significant feature of FMP 3.2 is the lowering of ABC levels for rockfish. For Aleutian Island and EBS other rockfish, the ABC was assumed to 200 mt and 400 mt, respectively. Because the BSAI other rockfish species are fished at less or equal to the ABC, and that the projected catches fall well below the OFLs, the direct and indirect effects under FMP 3.2 are considered either insignificant through mortality. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity; however, since the MSST is unable to be calculated, the other direct/indirect effects are unknown (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI other rockfish are summarized in Table 4.5-25.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

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

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are the same as those considered for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other rockfish 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 FMP 3.1 and FMP 3.2, 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 this FMP.

- **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 this FMP.

- **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 FMP 3.1 and FMP 3.2, 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 this FMP.

- **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/temporal concentration of the fishery is not expected to change significantly.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, 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 this FMP.

- **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 this FMP.

- **Cumulative Effects.** A cumulative effect 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 FMP 3.1, the change in habitat suitability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

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

- **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 this FMP.

- **Cumulative Effects.** Cumulative effects of the combined FMP indirect effects and the external effects 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.

GOA Northern Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass and Fishing Mortality

Under FMP 3.1 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.4-35 of Appendix H).

FMP 3.2 would reduce catch of GOA northern rockfish because it changes the biological reference point for determining rockfish ABCs from $F_{40\%}$ to $F_{60\%}$. Under FMP 3.2 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.4-35 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effects that FMP 3.1 has on the spatial/temporal concentration of northern rockfish catch depend on the decisions made by the 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 the NPFMC implemented some "rights-based" management scheme. Under FMP 3.1 the spatial/temporal concentration of fishing effort may also be affected by Pacific halibut bycatch considerations if they substantially change the distribution of fishing effort. Under FMP 3.1, the potential for localized depletion of the stock exists if fishing occurs year after year on localized aggregations of northern rockfish.

The effects that FMP 3.2 has on the spatial/temporal concentration of northern rockfish catch depends on the decisions made by the 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. The implementation of fishery rationalization should also spread the fishery out in time and space. FMP 3.2 may also potentially have a large effect on the spatial concentration of northern rockfish catch if 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.

Under FMP 3.2 the spatial/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 FMP 3.1 and FMP 3.2, the projected B2003 of 42,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected

B2005 of 40,400 mt for FMP 3.1, and 40,800 mt for FMP 3.2 are greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition and Sex Ratio

Under FMP 3.1 and FMP 3.2, 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 FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Under FMP 3.1 and FMP 3.2 damage to epifauna by bottom trawls may adversely impact juvenile northern rockfish habitat.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under FMP 3.1 and FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Northern Rockfish

Under FMP 3.1 and FMP 3.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 3.1 and FMP 3.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability, are believed to have an insignificant impact on stock sustainability (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for GOA northern rockfish are summarized in Table 4.5-26.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under FMP 3.1 and FMP 3.2.

- **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 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to northern rockfish mortality.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA northern rockfish is rated as insignificant. Northern rockfish are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA northern rockfish stock is expected to be insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries is identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Bycatch in the IPHC longline fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to northern rockfish change in biomass levels as a function of change in reproductive success (see below).

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** Impacts of the spatial/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 3.5.1.24 for change in reproductive success.

- **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 potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. The magnitude and direction of the change in reproductive success with water temperatures is currently unknown. Climate changes and regime shifts are not considered to be contributors to change in genetic structure.

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

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effect on northern rockfish prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on northern rockfish prey species (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since northern rockfish prey species bycatch is not expected to occur. Climate changes and regime shifts are identified as making potential beneficial or adverse contributions on prey availability, although the magnitude and the direction of change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect 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 northern rockfish stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effect on northern rockfish habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA northern rockfish stocks include past foreign, JV, and domestic fisheries, IPHC longline fishery and climate changes and regime shifts (see Section 3.5.1.24). Intense bottom trawling on northern rockfish habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries have also been identified as having adverse effects on northern rockfish habitat, although these effects are not expected to have been as intense as those effects associated with trawl gear. See Section 3.6 for additional information on the effects of trawling on benthic habitat. Climate changes and regime shifts have had both beneficial and adverse effects on northern rockfish habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has been identified as an adverse contributing factor since the fishery gear could disrupt spawning and/or rearing habitats. Although, as state above, the impacts associated with longline gear are not as significant as those associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the GOA northern rockfish stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect 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 northern rockfish stock to sustain itself at or above MSST is jeopardized.

GOA Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

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

FMP 3.1 is more precautionary in its approach than FMP 1, FMP 2.1, and FMP 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 FMP 3.1, which does not appear reasonable (Table H.4-34 of Appendix H).

FMP 3.2 is considerably more precautionary in its approach than the baseline situation or FMPs 1, 2.1, 2.2, and 3.1. FMP 3.2 has a major impact on catch of shortraker/rougheye because it includes a measure that changes the biological reference point for determining ABCs of rockfish in Tiers 1 through 4 (which includes rougheye rockfish) from the $F_{40\%}$ baseline to $F_{60\%}$. Using $F_{60\%}$ would reduce the ABC value for shortraker/rougheye, which would almost certainly result in a decrease in catch. Therefore, FMP 3.2 would greatly reduce the risk of overfishing shortraker/rougheye. One other measure in FMP 3.2 that would affect catch of shortraker/rougheye 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 shortraker/rougheye, thereby providing even greater protection against overfishing. The model projections for FMP 3.2 show shortraker/rougheye catches about 50 percent less than those taken by the fishery in recent years. The projections appear reasonable given the stringent precautionary measures of this bookend (Table H.4-34 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Whether this bookend would have substantial effects on the spatial or temporal concentration of shortraker/rougheye catch would somewhat depend on decisions made by the 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 the 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.

FMP 3.2 would have a large effect on the spatial/temporal concentration of shortraker/rougheye 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 FMP 3.2 sets aside 20 percent of the GOA as either no-take reserves or as MPAs. No-take reserves in the proposal cover various portions of the continental slope in the GOA that are inhabited by shortraker/rougheye. These include reserves off Cape Ommaney in southeast Alaska, off Portlock and Albatross Banks near Kodiak Island, off the entrance to Shelikof Strait, and other reserves south of the Alaska Peninsula and eastern Aleutian Islands, all of which correspond to important fishing grounds (both trawl and longline) for shortraker/rougheye (Fritz *et al.* 1998). Much of the past commercial catch for shortraker/rougheye has been taken on these grounds, so FMP 3.2 would likely displace this catch to other localities. Whether this displacement would result in spreading out the catches over a wider area, or would merely concentrate the catch in new localities, is unknown. 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.

Another important effect of FMP 3.2 is that all fisheries would become "rationalized", which would result in establishment of IFQs or cooperatives for all the trawl fisheries. The existence of IFQs or fishing cooperatives would mean 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 catches of shortraker/rougheye could extend over a longer time period. This would allow better management oversight of the catch and reduce the risk of over-harvesting.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be determined.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter. There is no information on the sex ratio of shortraker/rougheye, although sex ratio for many other species of Sebastes has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 3.1 and FMP 3.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, FMP 3.1 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 beneficial effect on shortraker/rougheye in this region.

Because FMP 3.2 creates a series of no-take reserves across the GOA, it may provide substantial habitat benefits to shortraker/rougheye. At present, shortraker/rougheye can be taken as bycatch on longlines anywhere in the GOA, although they cannot be caught by trawling in the eastern GOA because of the no-trawl closure in that region. FMP 3.2 retains the eastern GOA trawl closure, but it also adds a number of no-take reserves throughout the GOA in which all fishing activities are prohibited.

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 FMP 3.1 and FMP 3.2 hypothetically could affect the food supply of shortraker/rougheye. To protect Steller sea lions, FMP 3.1 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. Catch projections for walleye pollock in FMP 3.2 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. 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.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Shortraker/Rougheye Rockfish

The effects of FMP 3.1 and FMP 3.2 on shortraker/rougheye in the GOA are summarized in Table 4.7-1.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for GOA shortraker/rougheye rockfish are summarized in Table 4.5-27.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

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

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

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA shortraker/rougheye 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 FMP 3.1 and FMP 3.2, 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 an adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the change in biomass level are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery and State of Alaska shrimp are identified as non-contributing factors to GOA slope rockfish biomass level since bycatch is not expected to occur in these fisheries.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** The spatial/ temporal characteristics of GOA shortraker/rougheye rockfish under FMP 3.1 and FMP 3.2 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 beneficial or adverse effects on shortraker/rougheye rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA shortraker/rougheye rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors to the change in genetic structure and reproductive success of GOA shortraker/rougheye rockfish since bycatch in these fisheries is unlikely to occur.

- **Cumulative Effects.** A cumulative effect for the spatial/temporal characteristics of the GOA shortraker/rougheye rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA shortraker/rougheye rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on shortraker/rougheye rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery is identified as a non-contributing factor to shortraker/rougheye rockfish prey availability since bycatch of shortraker/rougheye rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since shrimp is a main prey item of rougheye rockfish.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA shortraker/rougheye rockfish; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA shortraker/rougheye rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA shortraker/rougheye rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. The IPHC longline fishery has been identified as a potential adverse contributor to shortraker/rougheye rockfish habitat suitability due to impacts from fishery gear. The State of Alaska shrimp fishery is a non-contributing factor since habitat degradation from shrimp fishery gear is not expected to occur. See Section 3.6 for more information on the impacts of fishery gear on EFH.

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

GOA Slope Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

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

FMP bookend 3.1 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 FMP 3.1, however, show ABCs much less than those for FMP 1, whereas the catches for FMP 3.1 are a little higher than those for FMP 1. Therefore, the model results do not seem plausible (Table H.4-31 of Appendix H).

FMP 3.2 is considerably more precautionary in its approach than the baseline situation or FMPs 1, 2.1, 2.2, and 3.1. FMP 3.2 primarily affects catch of slope rockfish in two ways: 1) it retains the eastern GOA trawl closure and also includes various smaller areas located throughout the GOA as "no-take" reserves, in which no fishing of any gear type can take place; and 2) it includes a measure that changes the biological reference point for determining rockfish ABCs from the $F_{40\%}$ baseline to a more conservative value, $F_{60\%}$. Both of these effects from FMP 3.2 would result in a decreased catch for slope rockfish and greatly reduce any risk of overfishing these species. As in FMPs 1, 2.2, and 3.1, the eastern GOA trawl closure protects most of the GOA biomass of slope rockfish from any significant fishing pressure. The smaller no-take reserves would serve to increase this protection even further. At present, changing the biological reference point for slope rockfish species to $F_{60\%}$ would affect just sharpchin rockfish, because the latter is the only slope rockfish species that is in Tier 4 and has the age data required to calculate $F_{60\%}$. Sharpchin rockfish; however, comprise almost 40 percent of the current exploitable biomass for slope rockfish; therefore, using $F_{60\%}$ for sharpchin rockfish would still result in a considerably lower overall ABC for slope rockfish. The model projections for FMP 3.2 show slope rockfish catches about the same as those for FMP 1 (the present management regime). Given the stringent precautionary measures of this bookend, one would expect the slope rockfish catches for FMP 3.2 to be somewhat less than the model indicates (Table H.4-31 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The main spatial effect of FMP 3.1 and FMP 3.2 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 FMP 3.1 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 FMP 3.1 . Whether FMP 3.1 would have much effect on the temporal concentration of slope rockfish catch would depend on decisions made by the NPFMC after this bookend was implemented. FMP 3.1 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 the 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 FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

No-take reserves located throughout the GOA, in which no fishing of any kind would be permitted, are also part FMP 3.2 and would serve to increase protection of slope rockfish even further. For example, the bookend includes a no-take reserve off Cape Ommaney in southeast Alaska, and this would prevent any catch of slope rockfish by longlines in this productive fishing area. 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.

FMP 3.2 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.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. There is no information on the sex ratio of slope rockfish, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 3.1 or FMP 3.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, FMP 3.1 greatly impacts habitat for slope rockfish because it closes the eastern GOA to trawling. This creates a de facto no-take zone or refugium for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species. 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.

Similar to FMP 1 and the baseline situation in past years, FMP 3.2 impacts habitat for slope rockfish mainly because it closes the eastern GOA to trawling. This creates a de facto no-take zone or refugium for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species. 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. FMP 3.2 also creates a series of no-take reserves across the GOA, which establishes de jure refugia for all species, including slope rockfish. These no-take reserves, although much smaller and of less impact to slope rockfish than the eastern GOA trawl closure, may provide additional habitat benefits to slope 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 FMP 3.1 and FMP 3.2 on predator-prey relationships for slope rockfish is unknown.

Summary of Effects of FMP 3.1 and FMP 3.2– GOA Slope Rockfish

The effects of FMP 3.1 and FMP 3.2 on slope rockfish in the GOA are summarized in Table 4.7-1.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for GOA slope rockfish are summarized in Table 4.5-28.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **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 an adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of other slope rockfish. The State of Alaska groundfish fisheries is identified as a non-contributing factor since catch and bycatch of slope rockfish species is already accounted for by the domestic groundfish fishery management. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect 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 FMP 3.1 and FMP 3.2, 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 an adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the other slope rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.24 and 3.10. The State of Alaska groundfish fisheries are identified as non-contributing factors to GOA slope rockfish biomass level. Although catch and bycatch do occur in these fisheries, the removals are already accounted for by the domestic groundfish fishery management.

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

Spatial/Temporal Concentration of Catch

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

- **Direct/Indirect Effects.** The spatial/temporal characteristics of GOA slope rockfish under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA slope rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA slope rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The State of Alaska groundfish fishery is identified as a non-contributing factor to the change in genetic structure and reproductive success of GOA slope rockfish. Although catch and bycatch of slope rockfish species occurs in these fisheries, they are not expected to contribute to localized depletion such that it leads to a detectable reduction in genetic diversity or reproductive success. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect for the spatial/temporal characteristics of the GOA slope rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA slope rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on slope rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to slope rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to slope rockfish prey availability since bycatch of slope rockfish prey species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA slope rockfish; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, State of Alaska groundfish fisheries and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA slope rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA slope rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to slope rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. The State of Alaska groundfish fishery and the IPHC longline fishery have been identified as potential adverse contributors to slope rockfish habitat suitability due to impacts from fishery gear. See Section 3.6 for more information on the impacts of fishery gear on EFH.

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

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

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; beginning in 2004, dusky rockfish will be managed under Tier 3. However, dusky rockfish has been modeled under the Tier 4 catgeory for the purposes of this analysis.

Fishing Mortality

FMP 3.1 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 FMP 3.1 that could affect catch of PSR is that PSC limits for Pacific halibut are reduced 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 FMP 3.1 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 FMP 3.1 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.4-32 of Appendix H).

FMP 3.2 is considerably more precautionary in its approach than the baseline situation or FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. FMP 3.2 has a major impact on catch of PSR because it includes a measure that changes the biological reference point for determining rockfish ABCs from the $F_{40\%}$ baseline to $F_{60\%}$. Using $F_{60\%}$ would significantly reduce the ABC value for PSR, which would almost certainly result in a decrease in catch. Therefore, FMP 3.2 would greatly reduce the risk of overfishing PSR. One other measure in FMP 3.2 that could affect catch of PSR is that PSC limits for Pacific halibut are reduced 30 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 FMP 3.2 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 FMP 3.2 show PSR catches about 50 percent less than those for FMP 1 (the present management regime), and the projected catches are 70-80 percent less than has been taken by the fishery in recent years. The projections appear reasonable given the stringent precautionary measures of this bookend (Table H.4-32 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Whether FMP 3.1 would have substantial effects on the spatial or temporal concentration of PSR catch would somewhat depend on decisions made by the 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 the 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.

FMP 3.2 would have a large effect on the spatial/temporal concentration of PSR 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 FMP 3.2 sets aside 20 percent of the GOA as either no-take reserves or as MPAs. No-take reserves in the proposal cover portions of Portlock and Albatross Banks, which are some of the major fishing grounds for dusky rockfish (Reuter 1999). Much of the past fishing effort for dusky rockfish has been concentrated on these two banks, so FMP 3.2 would likely displace this effort to other localities. Whether this displacement would result in spreading out the fishing effort over a wider area, or would merely concentrate the effort in new localities, is unknown. 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.

Another important effect of FMP 3.2 is that all fisheries would become “rationalized”, which would result in establishment of IFQs or cooperatives for the trawl fisheries. The existence of IFQs or fishing cooperatives would mean 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 fishery and reduce the risk of over-harvesting PSR species.

Status Determination

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

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish. There is no information on the sex ratio of PSR, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 3.1 and FMP 3.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, FMP 3.1 impacts habitat for PSR because it retains the eastern GOA trawl closure. This creates a de facto no-take zone or refugium for PSR in this area, as trawls are generally the only effective gear for capturing these species. Although biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA only contains about 10-15 percent of the Gulf-wide 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 Gulf-wide 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 beneficial 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.

Because FMP 3.2 creates a series of no-take reserves across the GOA, it may provide substantial habitat benefits to PSR. At present, the only de facto no-take reserve affecting PSR is the eastern GOA region that has been closed to trawling for the past several years. FMP 3.2 retains the eastern GOA trawl closure, and it also adds several no-take reserves in the central and western GOA.

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 FMP 3.1 or FMP 3.2 that affect the commercial catch of walleye pollock could have an subsequent indirect effect on dusky rockfish by increasing or decreasing the amount of euphausiids available to dusky rockfish. To protect Steller sea lions, FMP 3.1 (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 FMP 3.2 indicate catches would be reduced compared to FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. This would lead to an obvious increase in abundance of walleye pollock and possibly have an adverse effect on the food supply for dusky rockfish. 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.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Pelagic Shelf Rockfish

The effects of FMP 3.1 and FMP 3.2 on PSR in the GOA are summarized in Table 4.7-1.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for the GOA PSR complex are summarized in Table 4.5-29.

Mortality

- **Direct/Indirect Effects.** The effect of the fisheries on the mortality of the GOA PSR complex is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA PSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR mortality since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect 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 FMP 3.1 and FMP 3.2 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 adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR biomass levels since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect 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 FMP 3.1 and FMP 3.2 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 potential beneficial or adverse effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR genetic structure and reproductive success since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

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

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability of GOA PSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on PSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a potential adverse contributor to GOA PSR prey availability. The catch of shrimp in the shrimp fishery is expected to continue in the future. Marine pollution is identified as a potential adverse contributor to PSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA PSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability of GOA PSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries have been identified as having past persisting adverse effects on GOA PSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA PSR habitat suitability (see Sections 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR habitat suitability since the gear associated with this fishery is not expected to cause a significant impact to the benthic habitat. See Sections 3.5.1.24 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

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

GOA Demersal Shelf Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for demersal shelf rockfish species.

Fishing Mortality

Under FMP 3.1, there would be few effects on DSR species in the short-term, and for all intensive purposes this management plan would be similar to the current GOA FMP. As described previously for FMP 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 FMP 3.1 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 minimum stock size 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.

Under FMP 3.1, 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.4-33 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 the NPFMC has also recently approved a management measure that requires full retention of DSR species. Once approved by NOAA Fisheries, the measure will improve catch statistics and reduce discards and waste. These measures would continue in FMP 3.1.

Under FMP 3.1, 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 this FMP.

The projected catch of DSR in the eastern GOA would be lower under FMP 3.2 as a result of a more conservative exploitation rate for DSR species. The DSR ABC would now be based on a F60 rate, that would translate to about 200 mt (Table H.4-33 of Appendix H). Assuming TAC would be set below this figure, the effect would be less fishing mortality of DSR. Reduced mortality of DSR would likely benefit the population over time. Such a reduced TAC would eliminate the directed fishery for DSR in the eastern GOA. All DSR would be placed on "bycatch-only" status. A TAC of 200 mt would provide only enough quota to permit retention of DSR as bycatch in the halibut fishery. This level of fishing mortality will not have a significant impact on the ability of DSR species to maintain the current population.

Spatial/Temporal Concentration of Fishing Mortality

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 FMP 3.1 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 2 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 FMP 3.1. 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 FMP 3.1 would generate no significantly adverse impact on DSR stocks.

Reduced fishing mortality and improved catch data on DSR species under FMP 3.2 would likely result in the development of measures that would protect localized DSR stocks from overfishing. Other components of FMP 3.2 include establishing a network of MPAs along the continental shelf and slope of Alaska. Such closures could affect traditional fishing grounds and require fishermen to fish in different areas. It is presumed that such a program would be carefully designed to address important habitat features and areas where localized overfishing concerns exist. Through these measures, a more precautionary management policy could provide benefits to DSR, but such benefits cannot be determined at the present time.

Status Determination

The MSST cannot be determined for this stock complex.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA DSR species. The sex ratio of GOA DSR species is unknown.

Habitat-Mediated Impacts

Any habitat suitability impacts of FMP 3.1 and FMP 3.2, 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 FMP 3.1 or FMP 3.2. However, FMP 3.1 and FMP 3.2 would initiate a federal Marine Protected Area (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.

Predation-Mediated Impacts

As with habitat suitability indices, any effects to predator-prey relationships of FMP 3.1 and FMP 3.2 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 FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Demersal Shelf Rockfish

An age-structured population model for DSR rockfish is not used for DSR. Projections of future catch ABC and OFL levels were made by carrying forward the 2002 baseline values into the future. Under these assumptions, DSR rockfish stocks remain stable and are fished at less than the ABC in the eastern GOA, and the direct and indirect effects under FMP 3.1 are considered either insignificant or unknown (Table 4.7-1).

Additional information is needed to determine whether current abundance levels are truly sustainable over the long-term, including improved time series of catch (and bycatch) by species, and age and size composition data. FMP 3.1 would prioritize and initiate a research program that would address the data limitations described above. Better estimates of important life history parameters including growth rates, maturity schedule, and natural mortality rate would likely result in improved management and greater confidence that current mortality levels are not adversely affecting DSR.

A significant feature of FMP 3.2 is the lowering of ABC levels for DSR. For the eastern GOA, the DSR ABC would be reduced from 390 mt to approximately 200 mt. A TAC set below 200 mt would only provide sufficient resource to permit retention of DSR as bycatch in the halibut fishery. Because DSR are will be fished at less or equal to the ABC, mortality under FMP 3.2 is considered insignificant to DSR species. The spatial/temporal distribution of catch, change in biomass, change in prey availability and habitat suitability are determined to be unknown (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for the GOA DSR complex are summarized in Table 4.5-30.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR mortality since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA DSR 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 FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR biomass levels since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect 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 FMP 3.1 and FMP 3.2 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 potential beneficial or adverse effects on DSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and IPHC longline fisheries have been identified as non-contributing factors to GOA DSR genetic structure and reproductive success. Catch/bycatch of these fisheries is already accounted for by the domestic groundfish management or is not expected to occur (as in the case of the State of Alaska herring and shrimp fisheries). Marine pollution is identified as a potential adverse contributor to GOA DSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial/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 FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on DSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as potential adverse contributors to GOA DSR prey availability. Catch of herring in the herring fishery and the catch of shrimp in the shrimp fishery are expected to continue in the future. The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to GOA DSR prey availability since bycatch of DSR prey species in not expected to occur. Marine pollution is identified as a potential adverse contributor to DSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability of GOA DSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries and the IPHC longline fisheries have been identified as having past persisting adverse effects on GOA DSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA DSR habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as non-contributing factors to GOA DSR habitat suitability since the gear associated with these fisheries are not expected to cause a significant impact to the benthic habitat. The State of Alaska groundfish fisheries and the IPHC longline fisheries are identified as potential adverse contributors to DSR habitat suitability. See Sections 3.5.1.24 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

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

4.7.2 Prohibited Species Alternative 3 Analysis

4.7.2.1 Pacific Halibut

Pacific halibut are managed by the IPHC. Halibut bycatch in federal groundfish fisheries is controlled by the use of PSC limits. IPHC provides for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery.

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – 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 IPHC account for all removals of halibut including bycatch in other fisheries. Thus, if changes to the baseline condition of the stock occur, they are reflected in the quotas set for the directed fishery. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. Halibut are opportunistic predators with a wide range of prey species, and no significant change to prey structure is expected as a result of FMP 3.1 or 3.2. No evidence of fishery impact to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows.

Under FMP 3.1, halibut PSC caps would be reduced slightly (0-10 percent). Halibut bycatch mortality in the BSAI and GOA combined would decrease slightly from the present 6,800 mt by perhaps a few hundred mt. Reductions in halibut are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. This decrease could allow a corresponding increase in halibut catches by the directed fishery. Total removals would continue to be limited by IPHC to protect the halibut resource.

Under FMP 3.2, halibut PSC caps would be reduced moderately (10 to 30 percent). Halibut bycatch mortality in the BSAI and GOA combined would decrease moderately from the present 6800 mt by 1,000-2,000 mt. This would allow a corresponding increase in halibut catches by the directed fishery. Total removals would continue to be limited by IPHC.

Cumulative Effects Analysis FMP 3.1 – Pacific Halibut

A summary of the cumulative effects analysis associated with FMP 3.1 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 3.1 because current management of halibut by IPHC accounts for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects**. The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 3.1. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 3.1.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 3.1. Halibut are opportunistic predators with a wide range of prey species, and no significant change to prey structure is expected as a result of FMP 3.1.

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

- **Reasonably Foreseeable Future External Effects.** Halibut are opportunistic predators with a wide range of prey species. Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability for Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1.

Cumulative Effects Analysis FMP 3.2 – Pacific Halibut

A summary of the cumulative effects analysis associated with FMP 3.2 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 FMP 3.2, because current management of halibut by IPHC accounts for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 3.2. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 3.2.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut, since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 3.2. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of FMP 3.2.

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

- **Reasonably Foreseeable Future External Effects.** Halibut are opportunistic predators with a wide range of prey species. Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability for Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.2.

4.7.2.2 Pacific Salmon or Steelhead Trout

Pacific salmon are managed by the ADF&G, which also manages the salmon sport fisheries and permitted subsistence harvesting. They 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 levels 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 restriction of subsistence 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 FMPs is presented in Section 4.5.2.2. The cumulative effects analyses were based on two groupings of Alaska salmon in BSAI and GOA: chinook salmon and other salmon.

Direct/Indirect Effects FMP 3.1 and 3.2 – Pacific Salmon or Steelhead Trout

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

<u>BSAI – Chinook Salmon</u>

Under FMP 3.1, chinook salmon bycatch in the BSAI varies from approximately 26,000 fish in 2003, to 24,000 fish in 2008. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 14,000 to 18,000 fish during the next six years. This harvest represents approximately 4.7 to 6.0 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Such bycatch levels 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 FMP 3.2, chinook salmon bycatch in the BSAI varies from approximately 23,000 fish in 2003, to 19,000 fish in 2006 - 2008. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 11,000 to 16,000 fish during the next six years. This harvest represents approximately 3.7 to 5.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This FMP results in a minor to moderate (10 to 25 percent) reduction in western Alaska chinook salmon catches by approximately 2,000 fish per year. 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. Such bycatch levels are not detectable in natal streams, would have no detectable effects on commercial or subsistence harvests or escapement, and are not expected to impact the sustainability of the stock.

<u>BSAI – Other Salmon</u>

Under FMP 3.1, bycatch of other salmon in the BSAI varies from approximately 69,000 fish in 2003 down to 62,000 fish in 2008. Assuming 96 percent of other salmon bycatch is chum salmon, and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 12,000 to 13,000 fish during the next six years. This harvest represents approximately 1.1 to 1.2 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. Such bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests and escapement, and are not expected to impact the sustainability of the stock.

Under FMP 3.2, bycatch of other salmon in the BSAI varies from approximately 61,000 fish in 2003 down to 48,000 fish in 2007. Assuming 96 percent of this other salmon bycatch is chum salmon, and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 9,000 to 12,000 fish during the next six years. This harvest represents approximately 0.8 to 1.1 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This FMP results in bycatch ranging from minor to moderate reductions (10 to 25 percent) to no change (less than ten percent) in western Alaska chum salmon catches of approximately 1,000 to 2,000 fish per year. 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. Such bycatch levels are not detectable in natal streams, would have no detectable effects on commercial or subsistence harvests or escapement, and are not expected to significantly impact sustainability of the stock.

<u>GOA – Chinook Salmon</u>

Under FMP 3.1, chinook salmon bycatch in the GOA varies from approximately 11,000 fish in 2003 to 23,000 fish in 2008. Assuming 58 percent of GOA chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 6,000 to 13,000 fish during the next six years. This harvest represents approximately 2.0 to 4.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This FMP results in minor to moderate (10 to 25 percent) reductions of western Alaska chinook salmon catches of 2,000 to 3,000 fish per year. Such bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests and escapement, and are not expected to have a significant impact on sustainability of the stock.

Under FMP 3.2, chinook salmon bycatch in the GOA varies from approximately 8,000 fish in 2003 to 18,000 fish in 2008. Assuming 58 percent of GOA chinook salmon bycatch is of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 5,000 to 10,000 fish during the next six years. This harvest represents approximately 1.7 to 3.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This FMP results in a significant reduction (>25 percent) in western Alaska chinook salmon catches by approximately 3,000 to 6,000 fish per year. 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. Such bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests or escapement, and are not expected to significantly impact sustainability of the stocks.

GOA – Other Salmon

Under FMP 3.1, bycatch of other salmon in the GOA varies from approximately 4,000 fish in 2003 to 9,000 fish in 2008. Assuming 56 percent of other salmon bycatch is chum salmon, the bycatch could range from 2,000 to 5,000 fish during the next six years. The proportion of these fish from western Alaska is unknown. Assuming that all of these fish were from western Alaska, this harvest represents approximately 0.2 to 0.5 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This FMP results in a moderate (10 to 25 percent) to significant (>25 percent) reduction of western Alaska chum salmon catches by approximately 1,000 fish per year. However, these bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests and escapement, and are not expected to significantly impact the sustainability of the stock.

Under FMP 3.2, bycatch of other salmon in the GOA varies from approximately 3,000 fish in 2003 to 7,000 fish in 2008. This FMP results in a significant reduction (>25 percent) in western Alaska chum salmon catches of approximately 1,000 to 2,000 fish per year. 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. Such bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests or escapement, and are not expected to significantly impact sustainability of the stock.

Cumulative Effects Analysis FMP 3.1 – Pacific Salmon or Steelhead Trout

A summary of the cumulative effects analysis associated with FMP 3.1 in BSAI and GOA stocks are shown in Table 4.7-2. 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 bycatch levels predicted under this FMP 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. Therefore, the potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant under FMP 3.1.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries, while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of 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. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. In GOA, state commercial, subsistence, and sport fisheries exert effects on mortality of non-western other salmon populations; however, these fisheries are not viewed as having significant impacts to salmon stocks in the GOA, and are not considered contributing factors to mortality of salmon populations as a whole. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook and BSAI other salmon resulting from internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 3.1. Combined bycatch potential in the BSAI and GOA fisheries under this FMP could impede the successful recovery of western Alaska depressed stocks and impact sustainability of the stock as a whole. The combined effects of mortality on GOA other salmon resulting from direct catch, bycatch, and future events are considered insignificant under FMP 3.1.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 3.1 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 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. State hatchery enhancement programs occur in GOA, but do not include prey species of salmon. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 3.1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 3.1 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, salmon bycatch composition has not been determined. Potential effects of state commercial and subsistence fisheries, along with GOA 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 BSAI and GOA salmon populations. State 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 GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 3.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 3.1 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 salmon populations originating in the BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may play a role in the reproductive success of certain salmon populations. Stocks in GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks, and are considered a potential adverse contribution to the population as a whole. Other GOA salmon stocks are considered stable, so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for the population. Degradation of watersheds used by spawning salmon that is 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. Hatchery enhancement programs in the GOA may help to restore depressed stocks and maintain stable stocks in Alaska, and are considered potentially beneficial to the reproductive success of salmon. Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook and BSAI other salmon stocks could be impacted. 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 salmon and BSAI other salmon stocks. Although current stock status of GOA other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA other salmon stocks under FMP 3.1.

Cumulative Effects Analysis FMP 3.2 – Pacific Salmon or Steelhead Trout

A summary of the cumulative effects analysis associated with FMP 3.2 in BSAI and GOA stocks are shown in Table 4.7-2. 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 bycatch levels predicted under this FMP would not be 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. Therefore, the potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant under FMP 3.2.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries, while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow, and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of 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. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of BSAI and GOA chinook and BSAI other salmon depressed stocks, and are considered a potential adverse contribution to the population as a whole. Other salmon stocks in the GOA are not expected to be significantly impacted by these fisheries. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA, and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook and BSAI other salmon resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 3.2. Combined bycatch potential in the BSAI fisheries 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 are considered insignificant under FMP 3.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 3.2 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 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 change and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time. State hatchery enhancement programs that occur in 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 direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 3.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 3.2 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, salmon bycatch composition has not been determined, so potential effects of state 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 change and regime shifts are not expected to result in direct mortality that would potentially affect genetic structure of BSAI and GOA chinook and other salmon stocks. State 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 GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska are unknown under FMP 3.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 3.2 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 salmon populations originating in the BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may play a role in the reproductive success of certain salmon populations. Stocks in GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks, and are considered a potential adverse contribution to the population as a whole. GOA other salmon stocks are considered stable, so potential effects of state 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 contributors to possible changes in reproductive success of this population. Hatchery enhancement programs in the GOA may help to restore depressed stocks and maintain stable stocks in Alaska, and are considered potentially beneficial to the reproductive success of salmon.

Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook and GOA 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 other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from past, present, and future events (both human controlled and natural) cannot be determined for GOA stocks under FMP 3.2.

4.7.2.3 Pacific Herring

Pacific herring are managed by the ADF&G. Harvest policy and allocations among gear (user) groups are established by the Alaska Board of Fisheries. Annual harvest quotas are set by ADF&G under an exploitation rate harvest policy. Herring exploitation rates are capped at a maximum level of 20 percent statewide. All directed herring fisheries occur in state waters and are managed by regulatory stocks.

A detailed discussion of the modeling approach used in this analysis is included in Section 4.5.2.3. Given the low herring bycatch levels that are predicted across all FMPs, bycatch removals would not be expected to have significantly different impacts on herring abundance estimates between FMPs.

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – 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 for the following reasons: bycatch of herring in the groundfish fisheries is low, the fisheries do not target herring prey, and spatial/temporal overlap between the groundfish fisheries and herring habitat is minimal. In addition, annual quota setting processes implemented by ADF&G are responsive to fluctuations in herring biomass.

Cumulative Effects Analysis FMP 3.1 and FMP 3.2 – Pacific Herring

A summary of the cumulative effects analysis associated with Alternative 3 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 FMP 3.1 and FMP 3.2 given the low amounts predicted for herring bycatch, and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. The herring savings areas reduce herring bycatch potential by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s, with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have had long-term impacts on herring populations. In addition, past federal groundfish fisheries bycatch, combined with the directed state fisheries, have exceeded the state's herring harvest policy, and may still exert lingering effects on current herring populations in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur, but are closely managed by ADF&G. Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. State subsistence catch is 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 change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass. Fishing quotas are based on variable exploitation rates that account for declines in stock, and are capped at a maximum rate of 20 percent. Thus, although some persistent past effects may still be present on certain herring populations in the BSAI and GOA, the combined effects of mortality on Pacific herring resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1 and 3.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under FMP 3.1 and 3.2 due to the low estimates of herring bycatch and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in reproductive success occurs, it would most likely be reflected in corresponding changes to biomass, which are incorporated into ADF&G management plans for Pacific herring.

- **Persistent Past Effects.** As discussed in the analysis of cumulative effects on Pacific herring mortality, years of unregulated foreign harvest of herring and past federal groundfish fisheries bycatch that exceeded the state's herring harvest policy in the past 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 the EVOS still exist, and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur but are closely managed by ADF&G. Fishing quotas are based on variable exploitation rates that account for declines in stock. State subsistence fisheries catch is also accounted for in ADF&G herring management plans. Thus, these fisheries are not considered contributing factors to changes in herring reproductive success. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring reproductive success, especially for those populations that are still recovering from the EVOS in the GOA. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific herring depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass, and fishing quotas are based on variable exploitation rates that account for declines in stock. Although certain herring populations in the GOA have been impacted by the EVOS, the stock as a whole is considered to be recovering. Thus, some persistent past effects may still be present on certain herring populations in the BSAI and GOA, but the combined effects on Pacific herring reproductive success resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1 and 3.2.

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 FMP 3.1 and FMP 3.2 because groundfish fisheries do not target herring prey and current management by ADF&G is responsive to fluctuations in herring biomass, regardless of the cause associated with the change. Thus, if a change in prey availability did occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring.

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

- **Reasonably Foreseeable Future External Effects.** Pacific herring prey primarily on zooplankton which are not affected by state directed herring fisheries or state subsistence fisheries. Thus, these fisheries are not considered contributing factors to changes in prey availability for herring. Future acute and chronic marine pollution could occur, but effects on prey such as zooplankton are unknown. Long-term climate change and regime shifts could have impacts to many species that contribute to the prey structure of Pacific herring. The nature of these impacts depends on the direction of the climatic shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** Potential effects of future natural events, such as marine pollution and climatic shifts, on prey availability for Pacific herring are unknown for FMP 3.1 and FMP 3.2.

<u>Change in Habitat</u>

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under FMP 3.1 and FMP 3.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass and spatial/temporal overlap between the fisheries and herring habitat is minimal. However, if the groundfish fisheries were to somehow impact herring habitat, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring. In addition, the herring savings areas reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. The long-term effects of this event to herring habitat are unknown. It is presumed that the effects of the EVOS still exist, and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** No evidence of fishery impact on habitat of herring exists. Thus, fisheries are not considered contributing factors to changes in herring habitat at this time. Future acute and chronic marine pollution could occur and is considered potentially adverse to some herring habitat, especially those that are still recovering from the EVOS in the GOA. Long-term climate change and regime shifts are not expected to significantly change physical habitat of Pacific herring.

- **Cumulative Effects.** Potential impacts of future natural events, such as marine pollution and climatic shifts, in addition to lingering contamination from the EVOS on certain habitat of herring in the GOA exist, but effects are not known for FMP 3.1 and FMP 3.2.

4.7.2.4 Crab

Alaska king, bairdi Tanner crab, and opilio Tanner crab (also called snow crab) fisheries are managed by the State of Alaska, with federal oversight and following guidelines established in the BSAI king and tanner crab FMP (NPFMC 1989). Section 4.5.2.4 contains further information on current stock status and management of crab in Alaska.

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

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – Crab

Direct and indirect effects for all species of crab in BSAI and GOA include mortality, changes in biomass, reproductive success, prey availability, and habitat. These effects may be attributed to fishing activities (both directed and undirected), but may also be linked to natural events such as long-term climatic change and decadal regime shifts. Significance of these effects is based on the likelihood that population-level changes will result from internal events within the groundfish fishery. An effect that is considered insignificant corresponds to a change that is not likely to result in population-level effects on crab, or that lies within the range of natural variability for the species.

Cumulative Effects Analysis FMP 3.1 and FMP 3.2 – Crab

Summaries of the cumulative effects analysis associated with FMP 3.1 and 3.2 are shown in Table 4.7-2. 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 include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are each rated according to the same significance criteria as the direct/indirect effects of the fishery and are based on the potential for population-level effects.

<u>Mortality</u>

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

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of these crab species do not reflect large deviations from the current baseline condition, even though catch trends do increase and decrease throughout the five-year period. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished.

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 populations in the BSAI as a whole. The level of crab bycatch predicted for 2003 through 2007 would not be expected to further impede the recovery of these already depressed stocks. Thus, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch may persist.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. These fisheries are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. 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 the time of this writing. 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 populations is currently considered depressed. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks, and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. 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 direct catch, bycatch, and future external events on depressed stocks. Thus, cumulative effects of FMP 3.1 and FMP 3.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of golden king crab in BSAI and GOA were combined with those for blue king crab. The BSAI predictions showed increases in catch for FMP 3.1, and decreases in catch for FMP 3.2 over the next five years when compared to current catch rates. Model projections for GOA catch showed decreases in catch for both FMPs compared to current catch in this region. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of FMP 3.1 and FMP 3.2 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 may persist (see the previous discussion of persistent past effects on crab).

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. 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. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown. Thus, potential combined effects of mortality, resulting from past events, direct catch, bycatch, and future external events cannot be determined at this time for FMP 3.1 and FMP 3.2.

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of bairdi Tanner, red king, and blue king crab in GOA shows decreases from current catch levels for the next five years. 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 FMP 3.1 and FMP 3.2 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. It is unclear if possible decreases in crab catch proposed under these FMPs will mitigate driving factors of mortality in these stocks. FMP 3.1 and FMP 3.2 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 may persist (see previous discussion of persistent past effects on GOA crab).

- **Reasonably Foreseeable Future External Effects.** State 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 external fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential combined effects of mortality resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 3.1 and FMP 3.2. It is unclear if additional protection measures and decreased bycatch of crab put forth under these FMPs will mitigate the combined effects of mortality on severely depressed red king crab stocks. Cumulative effects of FMP 3.1 and FMP 3.2 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 BSAI

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of these crab species do not reflect large deviations from the current baseline condition, although catch trends do increase and decrease throughout the five-year period. 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 effect the crab populations in the BSAI as a whole. Thus, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on changes in biomass of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. We infer that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch may persist (see previous discussion of persistent past effects on crab).

- **Reasonably Foreseeable Future External Effects.** State 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 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 the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Potential effects of long-term climate change 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, present, and future events. Thus, cumulative effects of FMP 3.1 and FMP 3.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current biomass of golden king crab in BSAI and GOA, potential effects of FMP 3.1 and FMP 3.2 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 BSAI and GOA cannot be determined because catch composition is unknown, and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State crab, 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, but the overall stock status of golden king crab stocks in BSAI and GOA is unknown, and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Effects of long-term climate change 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 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. 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 BSAI and GOA are unknown. Thus, potential combined effects of changes in biomass resulting from direct catch, bycatch, and potential future events cannot be determined at this time for FMP 3.1 and FMP 3.2.

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of bairdi Tanner, red king, and blue king crab in GOA shows decreases from current baseline for the next five years. 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 FMP 3.1 and FMP 3.2 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. The effects of FMP 3.1 and FMP 3.2 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 occurred.

- **Reasonably Foreseeable Future External Effects.** State 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 fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Effects of long-term climate change 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. 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 and biomass estimates are unknown. Thus, potential combined effects of changes in biomass, resulting from past, present, and future events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 3.1 and FMP 3.2. It is unclear if additional protection measures and decreased bycatch of crab put forth under these FMPs, will mitigate the combined effects of mortality and corresponding changes to biomass for severely depressed red king crab stocks. Therefore, cumulative effects of FMP 3.1 and FMP 3.2 on GOA red king crab cannot be determined at this time.

Change in Reproductive Success

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

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. Changes in reproductive success within BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between spawning-recruitment success and depressed stock status cannot be concluded at this time. Therefore, the potential effects of FMP 3.1 and FMP 3.2 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. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Directed crab fishing seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. 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 the time of this writing. 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 change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. A relationship between spawning-recruitment success and other factors impeding reproductive potential to depressed stock status cannot be drawn at this time Thus, potential effects on reproductive success resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events are unknown for FMP 3.1 and FMP 3.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 3.1 and FMP 3.2 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 unknown.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success, resulting from past events, bycatch, and reasonably foreseeable future external events are unknown for FMP 3.1 and FMP 3.2.

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 3.1 and FMP 3.2 on changes to reproductive success cannot be determined. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery, while other GOA stocks are still considered depressed. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Changes in reproductive success within GOA crab populations may be an underlying factor in the depressed nature of these stocks. Therefore, the potential effects of FMP 3.1 and FMP 3.2 on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in 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 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, so these fisheries are not considered contributing factors to changes in reproductive success of these stocks. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the GOA may still exist, and some stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success, resulting from direct catch, bycatch, and reasonably foreseeable future external events are unknown for FMP 3.1 and FMP 3.2.

Change in Prey Availability

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, only BSAI opilio Tanner crab is included in this analysis.

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and it is unclear if FMP 3.1 and FMP 3.2 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 3.1 and FMP 3.2 on changes in prey availability cannot be determined.

- **Persistent Past Effects.** Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past fisheries is minimal. Thus, past effects on crab prey structure and availability in BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and these fisheries are not considered contributing factors to changes in prey availability. Rebuilding plans currently in effect in BSAI do not address crab prey structure and availability, and are not considered contributing factors to potential changes in prey availability. Long-term climate change and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the possible effects that these changes may have on crab populations throughout BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined and potential changes to prey structure, resulting from past, present, and future events cannot be determined for all species of crab in BSAI and GOA for FMP 3.1 and FMP 3.2.

Change in Habitat

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

- **Direct/Indirect Effects.** These stocks are currently considered depressed, and in some instances overfished. However, a direct link between changes to habitat and the depressed stock status of these crab species in the BSAI 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 these proposed FMPs, 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, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on changes in habitat of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of trawling and using other types of fishing gear that interact with bottom habitat. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab, 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. Possible habitat-related effects have not been determined. Long-term climate change and regime shifts are not expected to directly effect 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 these FMPs. Thus, potential effects on crab habitat, resulting from past events, internal bycatch, and reasonably foreseeable future external events, cannot be determined for FMP 3.1 and FMP 3.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout BSAI and GOA. Potential effects of FMP 3.1 and FMP 3.2 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 crab, scallop, and subsistence fisheries continue to occur. They 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 depressed nature of some golden king crab stocks in GOA currently. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** 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 zones, it is possible that other critical habitat areas are not included in these measures or those proposed under these FMPs. Thus, potential effects on golden king crab habitat, resulting from past, present, and future events, cannot be determined for FMP 3.1 and FMP 3.2, without first establishing the overall population and essential habitat status of this species.

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

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Red king and bairdi Tanner stocks in the GOA are currently considered depressed, while blue king crab stock status is unknown, but presumed to be depressed based on limited survey data. However, a relationship between changes to habitat and depressed stock status cannot be drawn 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 these proposed FMPs, 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 FMP 3.1 and FMP 3.2 on changes to bairdi Tanner, red king, and blue king crab habitat in 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 for GOA crab).

- **Reasonably Foreseeable Future External Effects.** State 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 change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist, and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of GOA crab is 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 these FMPs. Thus, potential cumulative effects on GOA bairdi Tanner, red king, and blue king crab habitat resulting from past, present, and future events cannot be determined for FMP 3.1 and FMP 3.2.

4.7.3 Other Species Alternative 3 Analysis

The Other Species category consists of the following species:

- Squid (order *Teuthoidea*).
- Sculpin (family *Cottidae*).
- Shark (*Somniosus pacificus, Squalus acanthias, Lamna ditropis*).
- Skate (genera *Bathyraja and Raja*).
- Octopi (*Ocotopus dofleini,Opistholeutis california,* and *Octopus leioderma*).

An aggregate TAC limits the catch of species in this category. Within the Other Species category, only shark are identified to the species level by fishery observers. Furthermore, the accuracy of catch estimates depends on the level of coverage in each fishery. Observer coverage in the BSAI is estimated at 70-80 percent, whereas the GOA has only approximately 30 percent observer coverage. Coverage can vary for certain target fisheries and vessel sizes (Gaichas 2002) (see Section 3.5.3).

Formal stock assessments for Other Species are not currently conducted in the BSAI and GOA, and biomass estimates for the species included in this category are limited and often unreliable. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. 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 adverse, beneficial, or neutral. There are numerous direct and indirect effects that may impact the current and future status of individual species within this group and/or this group as a whole. These effects are summarized in the section that follows.

Direct/Indirect Effects FMP 3.1 – 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 these non-target species groups is unknown, because information on stock status is lacking. For many non-target species, the differences in catch between the comparative baseline and FMP 3.1 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 3.1, total catch of BSAI squid and Other Species and GOA Other Species, is predicted to increase by several thousand tons per year, due to the predicted increases in catches of the target species with which Other Species are caught. Most of this increase is predicted in the catch of skate and sculpin in both areas. Catch projections for specific groups within BSAI and GOA Other Species are presented below.

<u>Squid</u>

In the BSAI, squid catch is predicted to increase slightly, 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.

Sculpin

Catches of BSAI sculpin are predicted to remain very close to currently observed catches. GOA sculpin catch is predicted to increase by 100 mt per year over the projection period.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of all of these species are predicted to remain stable throughout the projection period under FMP 3.1. As in the BSAI, shark catches in the GOA are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark. While all shark catch in the GOA is predicted to be relatively low, catches of other shark are predicted to increase by an order of magnitude, catches of sleeper shark and salmon shark are predicted to decrease slightly, and catches of dogfish will remain relatively similar to current 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, which is the same order of magnitude as current catches, and may warrant increased management attention if it actually occurrs.

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 data collection is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at 300 to 400 mt per year. The trace amounts of octopus catch reported in the GOA are predicted to decrease over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis FMP 3.1

A summary of the cumulative effects analysis associated with FMP 3.1 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Other Species is unknown under FMP 3.1. 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 Nonspecified Species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline conditions have not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA Other Species are unknown under FMP 3.1. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the Other Species complex is unknown. It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. This possible overexploitation could have impacts to reproductive success, if sex-ratios of these species are significantly altered, or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline conditions and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the Other Species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the Other Species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species within this complex is unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the Other Species population in BSAI and GOA are unknown under FMP 3.1. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the Other Species complex is unknown. It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the Other Species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA Other Species is unknown under FMP 3.1. The current baseline condition is unknown. Species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries. Formal stock assessments are not conducted for Other Species, and most biomass estimates for BSAI and GOA Other Species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP:

Other Species and Nonspecified Species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline conditions have not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the Other Species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the Other Species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

<u>Change in Habitat</u>

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA Other Species are unknown under FMP 3.1. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the Other Species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Direct/Indirect Effects FMP 3.2 – 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 these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 3.2 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 3.2, total catch of BSAI squid and Other Species is predicted to decrease by several thousand tons per year, and GOA Other Species is predicted to remain in a similar range to current levels. This is due to bycatch reduction incentives included in rationalization programs under this FMP. Most of this decrease in the BSAI is predicted in the catch of skate and sculpin. Catch projections for specific groups within BSAI and GOA Other Species are presented below.

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 in the same range as current catches for the first several years of the projection period, followed by a gradual increase, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so this increase may not cause different population impacts than current catch levels.

Sculpin

Catches of BSAI sculpin are predicted to decrease slightly (by 500 mt relative to current catches). GOA sculpin catch is predicted remain at currently observed levels over the projection period.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Pacific sleeper shark catch is predicted to decrease slightly relative to current catch, while catches of all other shark species are predicted to remain stable throughout the projection period under FMP 3.2.

Skate

The catch of BSAI skate is predicted to decrease by nearly 2,000 mt to about 15,500 mt within the modeled period. The decreased catch of skate is due primarily to bycatch reduction incentives included in rationalization programs under this FMP. In 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

Octopus catch in the BSAI is predicted to remain stable at 200 to 300 mt per year. The trace amounts of octopus catch reported in the GOA are predicted to decrease over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis FMP 3.2

A summary of the cumulative effects analysis associated with FMP 3.2 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Other Species is unknown under FMP 3.2. The current baseline condition is unknown and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited, while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline conditions have not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the Other Species complex, life history, and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA Other Species are unknown under FMP 3.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the Other Species complex is unknown. It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the Other Species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the Other Species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the Other Species population in BSAI and GOA are unknown under FMP 3.2. 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: Other Species and Nonspecified 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 fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the Other Species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA Other Species is unknown under FMP 3.2. The current baseline condition is unknown, and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries. Formal stock assessments are not conducted for Other Species, and most biomass estimates for BSAI and GOA Other Species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited, while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the Other Species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the Other Species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are therefore, unknown.

<u>Change in Habitat</u>

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA Other Species are unknown under FMP 3.2. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the Other Species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species also have diverse habitat preferences. Although persistent past effects potentially impacting habitat, could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

4.7.4 Forage Fish

The BSAI and GOA FMPs were amended in 1998 to establish a forage fish species category to prevent the development of directed fisheries on these ecologically important non-target species. Forage fish are described in more detail in Section 3.5.4.

Direct/Indirect Effects of FMP 3.1 – Forage Fish

<u>Total and Spawning Biomass</u>

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The incidental catch rates predicted for FMP 3.1 are not expected to affect biomass.

<u>Catch/Fishing Mortality</u>

A directed fishery on forage fish 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 FMP 3.1 indicate incidental catch of forage fish would remain low at a level similar to the current catch (Table H.4-22 in Appendix H). Over the next five years the pollock catch in the GOA is projected to grow rapidly under FMP 3.1 (Table H.4-41 in Appendix H). The increased pollock catch under this FMP is projected to lead to 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 small under FMP 3.1. 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.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under FMP 3.1.

Status Determination

The MSST of forage fish species is unknown at this time, but it is unlikely that management practices under FMP 3.1 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. However, it is assumed that the age and size composition of forage fish would not change under FMP 3.1. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 3.1.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data it would be extremely difficult to accurately assess the predator-prey impacts of FMP 3.1.

Summary of Effects of FMP 3.1- Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative assessment of the FMP's on these measures can be described.

A directed fishery for forage fish is prohibited by Amendments 36 and 39 in the BSAI and GOA FMPs. Therefore, the only direct effect of FMP 3.1 is incidental take of forage fish in other fisheries.

The model is able to estimate future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA. The bulk of the smelt bycatch comes from the pollock fishery. Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP.

Under FMP 3.1 the bycatch of forage fish in the BSAI remains at a low level similar to the current catch (Table H.4-22 in Appendix H). Under FMP 3.1, the GOA bycatch of forage species is projected to increase considerably in the next five years (Table H.4-41 in Appendix H). Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 3.1 is thought to be a relatively small fraction of the biomass and unlikely to effect the abundance of the stock in the BSAI and GOA.

Indirect effects of FMP 3.1 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 3.1.

Cumulative Effects Analysis of FMP 3.1 – Forage Fish

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 3.1.

- **Persistent Past Effects.** Persistent past effects have not been identified for fishing mortality in the BSAI or GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects.** Potential effects on mortality are indicated due to potential adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts are considered non-contributing factors, since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of forage fish (see Sections 3.5.4 and 3.10). Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish mortality; however, the removal of these species is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.

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

- **Reasonably Foreseeable Future Effects.** Potential effects on biomass are indicated due to the potential adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts have been identified as having potential beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.4 and 3.10. The Alaska subsistence and personal use fisheries have been identified as a potential adverse contributor to the change in biomass level of BSAI and GOA forage fish. Subsistence and personal use fisheries concentrate mostly on the smelt species; however, it is unlikely that these fisheries would have a population level effect.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 3.1 the effect of the spatial/temporal concentration of catch is unknown.

- **Persistent Past Effects.** Persistent past effects are not identified for the genetic structure of the BSAI and GOA forage fish. Climate changes and regime shifts are identified as influencing the reproductive success of BSAI and GOA forage fish. For example, some *Osmeridae* species have shown a decline in recruitment since the late 1970s, coinciding with increased water temperature.

- **Reasonably Foreseeable Future External Effects.** Potential effects on the reproductive success of forage fish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has been identified as a potential adverse contribution, since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as having potential adverse contributors to the genetic structure and reproductive success of BSAI and GOA forage species. As stated above, these fisheries mainly target smelt species; however, it is unlikely the removals in these fisheries would be large enough, and taken in a localized manner, such that would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects.** Persistent past effects are identified for the change in prey availability of the BSAI and GOA forage fish stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted. See Sections 3.5.4 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Potential effects of climate change and regime shifts on the BSAI and GOA forage fish stock can be either beneficial or adverse. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. Marine pollution has been identified as a potential adverse contribution, since acute and/or chronic pollution events could reduce prey availability or prey quality, and thus jeopardize the stocks ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to the prey availability of BSAI and GOA forage fish. However, the catch/bycatch of these species is expected to be minimal and unlikely to have a population level impact.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability; however, this effect is unknown. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects.** Persistent past effects identified for BSAI and GOA forage fish include climate changes and regime shifts. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information see Sections 3.5.4 and 3.10.

- **Reasonably Foreseeable Future External Effects.** Potential effects of climate change and regime shifts on the BSAI and GOA forage fish stock can be either beneficial or adverse. Marine pollution has been identified as a potential adverse contribution, since acute and/or chronic pollution events could cause habitat degradation, and may cause changes in spawning or rearing success. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish habitat suitability. For more information on the effects of fishery gear on EFH, see Section 3.6.

- **Cumulative Effects.** A cumulative effect is possible for BSAI and GOA forage fish habitat suitability; however, this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

Direct/Indirect Effects of FMP 3.2 – Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The incidental catch rates predicted for FMP 3.2 is 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 FMP 3.2 indicate incidental catch of forage fish would remain low at a level similar to the current catch (Table H.4-22 in Appendix H). Over the next five years the pollock catch in the GOA is projected to grow rapidly under FMP 3.2 (Table H.4-41 in Appendix H). The increased pollock catch under this FMP is projected to lead to 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 FMP 3.2. 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.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under FMP 3.2.

Status Determination

The MSST of forage fish species is unknown at this time, but it is highly unlikely that management practices under FMP 3.2 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. However, it is assumed that the age and size composition of forage fish would not change under FMP 3.2. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 3.2.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data it would be extremely difficult to accurately assess the predator-prey impacts of FMP 3.2.

Summary of Effects of FMP 3.2 – Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative assessment of the FMPs on these measures can be described.

A directed fishery for forage fish is prohibited by Amendments 36 and 39 in the BSAI and GOA FMPs. Therefore, the only direct effect of FMP 3.2 is incidental take of forage fish in other fisheries.

The model is able to estimate future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA. The bulk of the smelt bycatch comes from the pollock fishery.

Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP.

Under FMP 3.2, the bycatch of forage fish in the BSAI remains at a low level similar to the current catch (Table H.4-22 in Appendix H). Under FMP 3.2, the GOA bycatch of forage species is projected to increase considerably in the next five years (Table H.4-41 in Appendix H). Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 3.2 is thought to be a relatively small fraction of the biomass and unlikely to effect the abundance of the stock in the BSAI and GOA.

Indirect effects of FMP 3.2 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 3.2.

Cumulative Effects Analysis of FMP 3.2 – Forage Fish

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 3.2.

- **Persistent Past Effects.** Persistent past effects have not been identified for fishing mortality in the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects.** Potential effects on mortality are the same as those indicated under FMP 3.1.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.

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

- **Reasonably Foreseeable Future External Effects.** Potential effects on biomass are the same as those indicated under FMP 3.1.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown.

- **Persistent Past Effects.** Persistent past effects identified for the change in genetic structure and reproductive success of the BSAI and GOA forage fish are the same as those indicated under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** Potential effects on the reproductive success and genetic structure of forage fish are the same as those described under FMP 3.1.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.2, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects.** Persistent past effects identified for the change in prey availability are the same as those indicated under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** Potential effects on prey availability are the same as those indicated under FMP 3.1.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.2, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects.** Persistent past effects identified for the change in habitat suitability are the same as those indicated under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** Potential effects on habitat suitability are the same as those indicated under FMP 3.1.

- **Cumulative Effects.** A cumulative effect is possible for BSAI and GOA forage fish habitat suitability; however, this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

4.7.5 Non-Specified Species Alternative 3 Analysis

Grenadiers have been chosen to illustrate potential effects to non-specified species because they are currently the major catch in the non-specified FMP category. Non-specified species make up a large and diverse category, encompassing every species not listed in the current FMP as a target, prohibited, forage, or other species. Considering a single species group from this category such as grenadier, cannot possibly represent the diverse effects to all species in the category. However, because information is lacking for nearly all of these groups, and they are caught in small or unknown amounts (due to a lack of reporting requirements in this category), we discuss only potential effects to grenadier.

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 lack of a baseline condition. Changes in bycatch of grenadiers were predicted based on modeled changes in target species catches and population trajectories (sablefish target fisheries have the most grenadier bycatch). While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact grenadier populations, or whether these impacts might be adverse, beneficial, or neutral.

Direct/Indirect Effects FMP 3.1 – Non-Specified Species

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. For many non-target species, the differences in catch between the comparative baseline and FMP 3.1 are relatively small, such that diverse alternatives may have similar (though unknown) effects on each stock.

Under FMP 3.1, catch of grenadiers in both the BSAI and GOA is predicted to remain within or slightly above the currently observed range. In both areas, grenadier catch is predicted to increase slightly initially and then decrease following trends in the sablefish fishery.

Cumulative Effects Analysis PMP 3.2 - Non-Specified Species

A summary of the cumulative effects analysis associated with FMP 3.1 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 3.1. The current baseline condition is unknown, and catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier, and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion of the non-target species bycatch in the GOA, and mortality is therefore considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** For 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 with the non-specified complex, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.1.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier, and presumably all other species within the non-specified complex, are unknown under FMP 3.1. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of 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 category will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadier and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex is 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 FMP 3.1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier, and other species within the non-specified complex, populations in BSAI and GOA are unknown under FMP 3.1. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to the genetic structure of the population if 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, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality, and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For 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 is unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.1.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadier is unknown under FMP 3.1. The current baseline condition is unknown for all members of the non-specified complex, and species-specific catch information is lacking, since species identification does not occur in the fisheries. Formal stock assessments are not conducted, and biomass estimates in the BSAI and GOA for grenadier, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. The current non-management of 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 fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline conditions have not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadier and all other members of the non-specified group depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadier, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.1.

Direct/Indirect Effects FMP 3.2 – Non-Specified Species

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 in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 3.2 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 3.2, 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 be cut to one sixth of currently observed levels. In the GOA, catch is predicted to decrease to approximately 8,000 mt per year. This projected decrease is due primarily to bycatch reduction incentives included in the rationalization programs under this FMP.

Cumulative Effects Analysis 3.1 - Non-Specified Species

A summary of the cumulative effects analysis associated with FMP 3.2 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 3.2. The current baseline condition is unknown, and catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA and mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** For 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 with the non-specified complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier and all other species within the non-specified complex are unknown under FMP 3.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier, and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of 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 category will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadier and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex is 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 FMP 3.2.

<u>Change in Genetic Structure of Population</u>

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier and other species within the non-specified complex populations in BSAI and GOA are unknown under FMP 3.2. 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 category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to the genetic structure of the population if 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, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For 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 is unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are therefore, unknown for FMP 3.2.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadier is unknown under FMP 3.2. 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 biomass estimates in the BSAI and GOA for grenadier, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. The current non-management of 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 fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadier and all other members of the non-specified group depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadier, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.2.

4.7.6 Habitat Alternative 3 Analysis

This policy accelerates existing precautionary management measures through community or rights-based management, ecosystem-based management principles, and, where appropriate and practicable, increases habitat protection and imposes additional bycatch constraints. Under this approach, additional conservation and management measures would be taken as necessary to respond to social, economic or conservation needs, or if scientific evidence indicated that the fishery was adversely impacting the environment. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management.

Direct/Indirect Effects FMP 3.1 – Habitat

FMP 3.1 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. There are no additional bottom trawl closures relative to the baseline, and there will be minor decreases in fishing effort. Figure 4.2-4 (bookend first appears in a previous section) illustrates the current suite of year-round closures in the BSAI and GOA management areas. Thus impacts to habitat under FMP 3.1 should be similar to FMP 1 and FMP 2.2.

Direct and indirect effects of the FMP on habitat are discussed through changes to living habitat through direct mortality of benthic organisms, changes to benthic community structure through benthic community diversity, and geographic diversity of impacts and protection. Due to their habitat type differences, the Bering Sea, Aleutian Islands, and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

In the GOA, the multi-species model results indicate that the catch of most living habitats will decline under FMP 3.1 (Table 4.5-48). In the BSAI, the bycatch levels are all within about + or - 20 percent of the baseline. We believe that the model projections for the GOA are unrealistically low relative to the baseline. The model framework artificially constrained specific fisheries, such as rockfish, that historically have had a high bycatch rate of living substrates (Jim Ianelli, AFSC, personal communication). Based on past performance it is doubtful that such constraints will severely curtail the rockfish fishery. Therefore, a more realistic prediction is that bycatch levels would be about the same as the baseline.

The habitat impacts model predicts the following effects for FMP 3.1 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. A large expanse (8,000 square miles) of high fishing intensity potentially causes a 83 percent reduction in equilibrium biostructure level for Scenario 2 (i.e., 15 year recovery rate). Based on these results, there would be an insignificant change to mortality and damage to living habitat as a result of FMP 3.1. The rating is based on the insignificant change between FMP 3.1 projections and the comparative baseline.

- **Aleutian Islands.** There is no predictable difference from baseline. Therefore, the change resulting from FMP 3.1 on the baseline is insignificant. However, prevalence of long-lived species of coral in the bycatch is a particular concern in the Aleutian Islands under FMP 3.1. 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 $f = .10$ (total area swept once every ten years) results in an equilibrium level reduction of 85 percent relative to the unfished level. About nine 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 FMP 3.1 bycatch levels may have adverse consequences on habitat quality, and FMP 3.1 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 0.9 to 6.9 percent of the fishable area, and 3.8 percent to 29.0 percent of the fished areas. Only two percent of the fishable EEZ is impacted to a level potentially below 32 percent (Scenario 2) of unfished levels, but amounts to about 2,418 square miles of habitat in scattered concentrations. Therefore, for FMP 3.1, this change to mortality and damage to living habitat is insignificant.

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

- **Bering Sea.** Identical to the baseline and FMP 1, FMP 3.1 closures in the Bering Sea are mostly concentrated on sand substrate (Table 4.5-47). Only 27 percent of the geographical-habitat zones have ≥ 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, 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 3.1. However, very little geographic diversity of fishing impacts occurs within the closed habitats, and nearly all of the closures are not year-round. Figure 4.5-4 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.5-5 depicts just those areas closed to fixed gear only.

  Application of the habitat impacts model indicated that, depending on the sensitivity and recovery parameters thought plausible, fishing of this intensity could reduce the amount of biostructure in the area by 13 to 75 percent of its unfished equilibrium level (Table 4.5-49). Such biostructure includes sponges, soft corals, tunicates, and anemones (Heifetz *et al.* 2002, Malecha *et al.* 2003). In these habitat areas, there are no existing closure areas that 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 FMP 3.1 on benthic community diversity is insignificant. Similarly, the predicted effects of FMP 3.1 on geographic diversity of impacts is predicted to be insignificant.

- **Aleutian Islands.** Identical to the baseline and FMP 1, FMP 3.1 closures in the Aleutian Islands are concentrated in shallow water where four percent of the area is closed to bottom trawling year round for all species. However, as shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutians is closed to bottom trawling at one time or another during the year under this FMP. These closures are associated with sea lion rookeries. As in the baseline, there is very little diversity in protection. Less than one percent of the deep area is closed to bottom trawling. Figure 4.1-10 shows that none of the closure areas extend over any blocks of significant fishing effort. Figures 4.5-4 and 4.5-5 show the closure areas under FMP 3.1 broken down by gear type, bottom trawl and fixed gear, respectively. The Aleutian Islands bathymetry and habitat is distributed on a very fine scale, with fishing effort that is very patchy and in very small clusters. Based on these observations as compared to the baseline, the predicted effects of FMP 3.1 on benthic community diversity and geographic diversity of impacts are insignificant.

- **GOA.** Figure 4.5-6 shows that, as in the baseline, minimal geographic diversity of impact or protection results from the current suite of closed areas. Except for the southeast trawl closure which covers the entirety of several habitats, all other closures are inshore; none exist on the outer shelf or slope (see Figure 4.5-6). As shown on Table 4.5-49 and Figures 4.5-4 and 4.5-5, FMP 3.1 closes nearly 46 percent of the fishable area in the GOA to trawling at one time or another during the year. The inshore closure areas tend to be large relative to the size of bathymetric and habitat resolution scale, and thus tend to encompass much of a bathymetric feature. Based on these results, the predicted effects of FMP 3.1 on benthic community diversity and geographic diversity of impacts is insignificant.

Cumulative Effects on Bering Sea

Cumulative effects on habitat for FMP 3.1 are summarized on Table 4.5-50. The following discussion of the results presented on the table is broken down by geographic area.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the 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 as described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution, all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use are possible at several locations in the Bering Sea area including Port Moller, Port Heiden, Dillingham, St. Paul, and St. George. The impacts include mortality due to smothering and/or burying, and would affect 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. 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 effects for FMP 3.1 are rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue, and add to the adverse cumulative effects on benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the 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 as described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution all have the potential to cause changes to benthic communities. Long-term (i.e., change to a weather pattern) wind induced waves and surges could also cause sufficient changes to the substrate, impacting that the benthic community. 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 Nina events have been identified as having impacts on both the physical and biological systems in the North Pacific. These changes could have either beneficial or adverse effects on the benthic community (see Sections 3.6 and 3.10).

- **Cumulative Effects.** 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 effects of FMP 3.1 are rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue, and add to the adverse cumulative effects to benthic living habitat.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected, since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 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 efforts 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 nine 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** include port expansion and the potential resultant changes to offal discharge and marine pollution episodes. As ports in the Bering Sea are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, the opening of new ports may allow vessels of all sizes to access new or relatively unfished areas. On the other hand, depending on distribution, fishing pressure in heavily fished areas may be eased as access to other areas becomes available. Closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 3.1 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 FMP3.1 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 past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear (see internal effects discussion and baseline description in Section 3.6). The additional external impacts do not provide any protection, and could add to the lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 3.1 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.

Cumulative Effects on Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral make impacts a particular concern in the Aleutians. Mortality of long lived species such as tree corals and other sessile epifauna, is likely to be persistent in these areas. The areas historically and recently closed to fishing as described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Dredging 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 in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use are possible at several locations in the Aleutian Islands including Atkutan, Adak, Unalaska, Cold Bay, Dutch Harbor, and King Cove. The impacts include mortality due to smothering, and/or burying, and would only affect 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. Even though the direct/indirect effects of FMP 3.1 are rated as insignificant, bycatch and damage to living habitat in the Aleutians will continue, and will add to the adverse cumulative consequences to benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing as described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline, and pot fisheries, offal discharge, port expansion and use, and marine pollution, all have the potential to cause changes to benthic communities. Long-term (i.e., a change to a weather pattern) wind induced waves and surges could cause sufficient changes to the substrate, impacting the benthic community. 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 Nina events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Aleutians. The additional external impacts described above will add to the lingering past mortality impacts, and contribute to impacts that are already evident. Thus, even though direct/indirect effects of FMP 3.1 are rated insignificant, continued bycatch and damage to living habitat will add to the adverse effects on the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. 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 efforts focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries, in order to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980, about 31 percent of the fishable area in the Aleutians was closed to trawling, with about six percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to offal discharge, and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted, or allowed to recover. As with the Bering Sea, ports in the Aleutians will be expanded and new ports created, and additional dock space for harboring the fishing fleet will be made available. While the fleet might not necessarily expand, the distribution of fishing effort is likely to change, and previously 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 FMP 3.1 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.

Cumulative Effects on GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As described for the Bering Sea and Aleutian Islands, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Port expansion and increased use are possible at several locations in the GOA including Kodiak, Sand Point, Chignik, Port Lions, Ouzinkie, Valdez, and Seward. Impacts include mortality due to smothering and/or burying, and would likely only affect nearshore zones and bays. Marine pollution is 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 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. Even though the direct/indirect effects of FMP 3.1 are rated as insignificant, continued bycatch and damage to living habitat in the GOA will add to the long-term and potentially irreversible adverse cumulative effects of fishing on the mortality of benthic organisms.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline and pot fisheries, offal discharge, port expansion and use, 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 effects of FMP 3.1 are rated as insignificant, bycatch and damage to living habitat will continue in the GOA, and will add to the adverse cumulative effects of fishing.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. 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 five 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. In 1980, about 73 percent of the fishable area in the GOA was closed to some type of fishing 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 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 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 FMP 3.1 would protect more benthic habitat from trawl gear in the future (46 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under the FMP 3.1 may not protect the full range of habitat types. In 1980, more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under FMP 3.1 (<1 percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. The additional external impacts described above will add to the lingering impacts and contribute to impacts that are already evident.

Direct/Indirect Effects on FMP 3.2 – Habitat

One objective of FMP 3.2 is to implement new changes to existing precautionary measures on a more rapid time line. This FMP contains a composite of several different concepts for habitat protection and mitigation. Figure 4.2-5 (bookend) illustrates the suite of year-round closures in the BSAI and GOA management areas. In future years, this composite may not reflect what actually is done. Actions that are actually implemented in future years, may reflect only a part of this composite of strategies. These conceptual strategies are:

- Close specific areas of the GOA upper slope to bottom trawling that possess sensitive hard bottom habitats impacted by the rockfish fishery.

- Incorporate a band-approach where closures would be oriented perpendicular to depth contours from near shore 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.

- Rotate 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.** These conceptual closures illustrate how the effects of fishing on habitat can be mitigated by reducing the impacts caused by a particular fishery. This strategy 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 preliminary run of the habitat impacts model. Further research may identify other fisheries and areas that would be better candidates for habitat mitigation. The exact location used in the analysis does not correspond to those areas being studied by the NPFMC and NOAA Fisheries in the EFH SEIS. 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 (Table 4.1-8).

  The NPFMC and NOAA Fisheries should 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 of closures. If closures are placed primarily in areas with high fish densities, and effort shifts into 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. FMP 3.2 does illustrate a scenario of reduced TACs, and the use of fishery cooperatives combined with no-take reserves and MPAs. It is important to point out that closures alone, if they are strategically placed within historically fished areas, can provide benefits to habitat 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.** Rotational closures have been suggested as a strategy to protect seafloor habitat, while not permanently closing an area to fishing. 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 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, while 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 potentially harbor the highest diversity and abundance of cold water corals and sponges in the world (Heifetz *et al.* 2002). A recent expedition to the Aleutian Islands explored coral and sponge habitat in the Aleutian Island 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. Probable anthropogenic disturbance to epifauna was observed at most dive sites, and may have been more evident in heavily fished areas. Coverage of corals ranged from approximately five 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 depth. 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 a special management regime that protects this habitat while still allowing fishing. Strategically placed closures in areas of sensitive habitat would protect this 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 near shore 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 locations. Ideally, these closures would be placed to ensure that a diversity of habitat types are protected. However, lacking good scientific information on distribution of habitat types, alternatives would be to randomly place the closures, or systematically place the closures at equal distances from one another. 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 random placement is that 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.

Direct and Indirect Effects FMP 3.2

Direct and indirect effects of the FMP on habitat are discussed through changes to living habitat through direct mortality of benthic organisms, changes to benthic community structure through benthic community diversity, and geographic diversity of impacts and protection. Due to their habitat type differences, the Bering Sea, Aleutian Islands, and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

In the GOA, the multi-species model results indicate that the bycatch of living habitat is projected to decline substantially under FMP 3.2. A decline in the bycatch of living substrates is realistic because FMP 3.2 has reduced TAC levels for some target species, especially rockfish. These reduced TACs should result in less fishing effort. Further effort controls would result from increased use of fishery and community-based cooperatives. While designed to address overcapacity and allocation issues, an indirect benefit of these programs appears to be reduced bycatch.

If the magnitude of such declines is actually realized, there could be 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 FMP 3.2 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 insignificant relative to the baseline. 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, qh, and) in the open and closed areas. There is little information to indicate that habitat density and 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 could occur due to the specific closures depicted by the FMP 3.2 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, there would be a significantly beneficial change to mortality and damage to living habitat as a result of FMP 3.2.

- **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 an increased effort to catch fish in lower density open areas. This 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, under certain conditions, there could be significantly adverse changes to mortality and damage to living habitat as a result of FMP 3.2. The internal effect is rated as conditionally significant adverse.

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

- **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, with several covering a small fraction of the heavily fished areas. Some of the closures for this FMP are located in light fishing effort areas, 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 some point during the year under FMP 3.2. Figure 4.7-3 shows areas closed to trawling at various times of the year under this FMP, while Figure 4.7-4 depicts only those areas closed to fixed gear. Based on these results, the predicted effects of FMP 3.2 on benthic community diversity is conditionally significant beneficial. The predicted effects of FMP 3.2 bookend on geographic diversity of impacts is also significant beneficial.

- **Aleutian Islands.** Closures illustrated in FMP 3.2 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 Aleutians is closed to bottom contact at some point during the year under this FMP. 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 FMP 3.2 by gear type, bottom trawl, and fixed gear. 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. Figure 4.7-1 shows that several closed 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 predicted effects of FMP 3.2 on benthic community diversity is conditionally significant beneficial. The predicted effects of FMP 3.2 bookend on geographic diversity of impacts is significant beneficial.

- **GOA.** Closures illustrated by the FMP 3.2 bookend are well distributed among geographical habitat types. Slight improvement in geographic diversity of impact would result from this FMP. As shown in Table 4.5-49, and Figures 4.7-3 and 4.7-4, FMP 3.2 closes over 72 percent of the fishable area in the GOA to bottom contact at some point during the year. The closure areas are large in relation to the GOA spatial habitat or bathymetric resolution, and 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 include only portions of 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 do not need to be as large in size as illustrated in this FMP 3.2 scenario. Based on these results, the predicted effects of FMP 3.2 bookend on benthic community diversity and geographic diversity of impacts is found to be insignificant relative to the baseline.

Cumulative Effects FMP 3.2 on Bering Sea

A summary of cumulative effects for habitat in FMP 3.2 are summarized on Table 4.7-3. The following discussion of the results presented in the table is presented by geographic area.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. These effects include persistent mortality of long lived species such as tree corals and other sessile epifauna. See the cumulative effects discussion for FMP 3.1 for additional details.

- **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 FMP 3.1 cumulative effects discussion for the Bering Sea.

- **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 parameters would differ between the open and closed areas, and the baseline condition is considered to be adversely impacted. Although some benefits accrue within 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. It is unclear where future closures may be located, 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, the cumulative effect of FMP 3.2 on mortality is conditionally significant adverse.

  However, if the closures proposed under FMP 3.2 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. Under these conditions, cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects result in a conditionally significant beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Bering Sea. See the cumulative effects write-up for FMP 3.1 for additional information.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities as described for FMP 3.1. 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. FMP 3.2 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 closed areas are not refined and may not be effective in protecting benthic community structure. For these reasons, along with the already impacted state of the benthic communities and the external adverse impacts, FMP 3.2 is rated as conditionally significant adverse.

  However, as described above for mortality, if the closures proposed under FMP 3.2 were to be further defined and designed to protect important habitats, mitigation of fishing-related impacts could occur, and cumulative effects may have more of a conditionally significant beneficial rating than a conditionally significant adverse.

<u>Geographic Diversity of Impacts and Protection</u>

- **Direct/Indirect Effects.** As described above, these effects result in a significantly beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remained closed. Figures 3.6-6 and 3.6-7, and Table 4.5-51 show that in 1980, almost nine 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 FMP 3.1 provides additional discussion regarding these past effects.

- **Reasonably Foreseeable Future External Effects** include port expansion and the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes (see the discussion for FMP 3.1). 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.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in the distribution of fishing effort. The maps and statistics discussed above show that FMP 3.2 would protect more benthic habitat from trawl gear in the future (33 percent), than was protected in 1980 (8.6 percent). Closure areas under FMP 3.2 cover a portion of high fishing intensity, providing improvement in the geographic diversity of impacts. However, 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, because 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.

Cumulative Effects on Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long lived species of coral make impacts a particular concern in the Aleutians. Mortality of long lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the FMP 3.1 cumulative effects discussion).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 (cumulative effects in the Aleutians) 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 already considered to be adversely effected. The proposed no-take MPAs will allow some benefits to accrue, but impacts will still occur, especially if the TAC remains high. The overall cumulative 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.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects result in a significantly beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see the FMP 3.1 cumulative effects discussion).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, 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 Aleutians. As described above for mortality of benthic organisms, the existing impacted baseline, combined with the uncertain benefits of the proposed MPAs, leads to a significantly adverse cumulative effects. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a cumulative effects rating of conditionally significant beneficial.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects result in a significantly beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected, because fishing effort and distribution has changed over time as areas have been closed and remained closed. Figures 3.6-6 and 3.6-7, and Table 4.5-51 show that in 1980, about 31 percent of the fishable area in the Aleutians was closed to trawling, with about six percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time (see the FMP 3.1 cumulative effects discussion).

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and 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 FMP 3.1).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 3.2 would protect more benthic habitat from trawl gear in the future (80 percent) than was protected in 1980 (31 percent). Closures illustrated in FMP 3.2 bookend are well distributed among geographical habitat types; improvement in geographic diversity of impacts would occur under this FMP scenario. Because 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 since 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.

Cumulative Effects on GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects are considered 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 cumulative effects discussion for FMP 3.1 in the GOA).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, 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. However, as described for the Bering Sea, focusing and refinement of the closure areas could lead to a conditionally significant beneficial effect.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above, these effects result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see the FMP 3.1 cumulative effects section for the GOA).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 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 both the Bering Sea and Aleutian Islands, while the FMP provides for additional closure area and no-take MPAs, impacts are not totally eliminated, and proposed MPAs might not be effective. The combination of internal and external impacts on benthic communities creates a conditionally significant adverse cumulative effect. 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, these effects result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected because fishing effort and distribution has changed over time as areas have been closed and remained closed. Figures 3.6-6 and 3.6-7, and Table 4.5-51 show that in 1980, about five 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. In 1980, about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at some point during the year (see FMP 3.1 for additional discussion).

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion, and the potential resultant changes to distribution of fishing effort (see FMP 3.1 cumulative effects discussion for details). 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 FMP 3.2 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 FMP 3.2 bookend are well distributed among geographical habitat types. However, slight improvements in geographic diversity of impacts would result, and as described above for the Bering Sea and Aleutian Islands, the proposed MPAs might not be effective. Further refinement of the proposed MPAs may lead to a conditionally significant beneficial cumulative effects rating.

4.7.7 Seabirds Alternative 3 Analysis

4.7.7.1 Short-Tailed Albatross

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

FMP 3.1 would adopt the new seabird protection measures for longline vessels that are based on the joint recommendations of NOAA Fisheries, USFWS, and the Washington Sea Grant Program and are currently undergoing agency and public review before being enacted (68 FR 6386). As described in Section 4.5.7.1, these new regulations are expected to substantially reduce the chances of taking short-tailed albatross on longlines. Since the measurable frequency of that mortality already approaches zero, and the population appears to be growing at a rate close to the theoretical maximum for the species, the reduced level of mortality under the new regulations is considered to be insignificant at the population level for the species. NOAA Fisheries and USFWS are currently researching the risk of short-tailed albatross incidental take due to collisions with trawl third wires. FMP 3.1 would incorporate any mitigation measures that arise from this research if it is considered necessary to protect the species. For these reasons, FMP 3.1 is considered to have insignificant effects on short-tailed albatross through incidental take in the fishery.

Seabird protection measures under FMP 3.2 would continue to be improved by scientifically based innovations in fishing techniques. The overall goal of the policy would be to reduce the incidental take of all seabird species, with special emphasis on ESA-listed species. The recent collaborative effort between NOAA Fisheries, USFWS, Washington Sea Grant Program, and the longline industry (Melvin *et al.* 2001) would likely be used as a model for the development of additional seabird protection measures. Since FMP 3.2 would seek to reduce take for all seabird species and some species are taken more often in trawls than on longlines, new mitigation measures aimed at reducing take in trawl gear or from collisions with third wires would be investigated. The potential reduction in the chances of taking short-tailed albatross in all fishing operations would certainly receive high priority in the research. It is likely that the overall chance of taking short-tailed albatross under FMP 3.2 would be much less than under the baseline conditions, which already approach zero. FMP 3.2 would therefore be considered to have an insignificant effect on short-tailed albatross through incidental take.

Changes in Food Availability

Short-tailed albatross forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 3.1 or FMP 3.2. Both FMPs 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 FMP 3.1 or FMP 3.2. Both FMPs are considered to have no effects on short-tailed albatross through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on short-tailed albatross are described in Section 3.7.4 (Table 3.7-12) and the predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for 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 are summarized below.

Mortality

- **Direct/Indirect Effects.** Under both FMP bookends, 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, although the risk would not be eliminated. 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, including volcanic eruptions on their main breeding site, Torishima Island, and increased rates of incidental take in fisheries throughout their range. If the species experiences a substantial increase in mortality that threatens its recovery, it may lead to further efforts to protect the species from fishery interactions.

- **Cumulative Effects.** Since the population of short-tailed albatross is susceptible to several natural and human-caused mortality factors that may or may not occur in the future, including incidental take in the groundfish fisheries under FMP 3.1, the cumulative effect on short-tailed albatross is considered to be conditionally significant adverse at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under both FMP bookends. This effect is considered insignificant at the population level for short-tailed albatross.

- **Persistent Past Effects.** Short-tailed albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to natural fluctuations in primary productivity and oceanographic factors. Pollution from a variety of land and marine sources have potentially affected short-tailed albatross prey in the past, but specific toxicological effects are unknown.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on short-tailed albatross prey availability. Pollution is likely to affect short-tailed albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to short-tailed albatross, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of short-tailed albatross prey is considered to be insignificant at the population level.

Benthic Habitat

Since short-tailed albatross feed at the surface, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for short-tailed albatross.

4.7.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

The new seabird protection measures for longline vessels under FMP bookends 3.1 and FMP 3.2 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). NOAA Fisheries is currently in the process of finalizing the new seabird deterrent regulations for the longline fleet. However, most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season. Incidental take data from the 2002 season should give some indication of the potential effectiveness of the new regulations in reducing take of albatross. Incidental take data are reported in the annual SAFE, Ecosystems Considerations Report. Data from the 2002 season will be available in the 2003 SAFE (see Comment Analysis Report [Appendix G] for updated statistics and analysis).

The incidental take of albatross in trawl gear and third wire collisions would receive attention under FMP 3.1 and even more attention under FMP 3.2. New trawl fleet regulations based on scientifically effective mitigation techniques would reduce incidental take of albatross to levels well below the baseline condition, which are already considered to be insignificant at the population level. Since the baseline level of incidental take for both albatross species is considered insignificant at their respective population levels (Section 4.5.7.2), the overall effect of FMP 3.1 and FMP 3.2 on the incidental take of these albatross species is considered insignificant.

Changes in Food Availability

Albatross forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 3.1 or FMP 3.2. Both FMP bookends 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 FMP 3.1 or FMP 3.2. Both FMP bookends are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

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. 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 FMP 3.1 and FMP3.2, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed. These measures are expected to reduce incidental take of both albatross species. 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, a smaller contribution from the BSAI/GOA longline fisheries, and an unknown contribution from other longline fisheries (IPHC), trawl fisheries, and vessel collisions throughout their range. Both species have been experiencing population declines over the past decade. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown for both albatross species.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets and are expected to reduce take of albatross in those fisheries. 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 FMP 3.1 and FMP 3.2, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level.

<u>Changes in Food Availability</u>

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 3.1 and FMP 3.2. 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 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. Pollution from a variety of land and marine sources have potentially affected albatross prey in the past. However, very little is known about the specific toxicological effects on species important to albatross or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on albatross prey availability. Pollution is likely to affect albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to albatross, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of albatross prey is considered to be insignificant at the population level for all species.

<u>Benthic Habitat</u>

Since albatross feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.7.7.3 Shearwaters

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

The new seabird protection measures for longline vessels under FMP 3.1 and FMP 3.2 would not be expected to result in a reduction of incidental take of shearwaters, which would remain approximately at the baseline level (about 600 birds per year, Tables 3.7-2 and 3.7-3), since the new deterrence techniques are not effective for these species (Melvin *et al.* 2001). Additional research into weighted ground lines may prove effective for deterring diving birds and may lead to additional seabird protection measures in the future, especially under FMP 3.2. The incidental take of shearwaters in trawl gear and third wire collisions could receive attention under FMP 3.1 and even more attention under FMP 3.2. Potential future trawl fleet regulations based on scientifically effective mitigation techniques would likely be based on their capacity to avoid mortality of albatross but may prove effective for shearwaters as well. Since the baseline level of incidental take for these species is considered insignificant at their respective population levels (Section 4.5.7.3), the overall effect of FMP 3.1 and FMP 3.2 on the incidental take of shearwater species is considered insignificant.

Changes in Food Availability

Shearwaters forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 3.1 or FMP 3.2. Both FMP bookends are considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Shearwaters are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 3.1 or FMP 3.2. Both FMP bookends are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on these shearwater species are described in Section 3.7.6 (Tables 3.7-14), and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.5-54). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.3 (Table 4.5-54) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed, but are not expected to reduce incidental take of the shearwater species. 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 are some indications that both species may be declining. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown for these species.

- **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.** 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. The cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally significant adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid as bycatch under FMP 3.1 and FMP 3.2. 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 have potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds, or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on shearwater prey availability. Pollution is likely to affect shearwater prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to shearwaters, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of shearwater prey is considered to be insignificant at the population level for both species.

Benthic Habitat

Since shearwaters feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.7.7.4 Northern Fulmar

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

Northern fulmars constitute the majority of birds taken incidentally in all sectors of the groundfish fisheries (Section 4.5.7.3), and they would likely benefit the most from improved seabird protection measures in both the longline and trawl fleets. Because most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season, incidental take data from the 2002 season should give some indication of the potential effectiveness of the new regulations in reducing take of fulmars. Incidental take data are reported in the annual SAFE, Ecosystems Considerations Report. Data from the 2002 season will be available in the 2003 SAFE (NPFMC 2003b) (see Comment Analysis Report [Appendix G] for updated statistics and analysis). Since the baseline level of incidental take is already considered insignificant at the population level, the substantially reduced levels of take expected under FMP 3.1 and FMP 3.2 would be considered insignificant at the population level. These reductions in take would greatly reduce concerns about potential colony level effects, although the Biological Research Division (BRD) of the USGS would likely continue to investigate the issue. The overall effect of FMP 3.1 and FMP 3.2 on fulmars is therefore considered to be insignificant through incidental take.

Changes in Food Availability

Fulmars forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 3.1 and FMP 3.2. Both FMP bookends 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 FMP 3.1 and FMP 3.2. Both FMP bookends are considered to have no effects on fulmars through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

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. 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 these FMP bookends, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed, and additional measures for the trawl fleet would be investigated. These measures are expected to reduce incidental take of fulmars substantially below the baseline level of incidental take, which is 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 related to the groundfish fisheries. Other potential mortality factors that have been identified include acute and chronic effects of pollution, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation) due 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 pollution incidents are likely but their effects on fulmars will depend on many factors that can not be predicted.

- **Cumulative Effects.** The population of northern fulmars appears to be stable and the primary human-caused mortality factors, including contributions from the groundfish fisheries under FMP 3.1 and FMP 3.2, are expected to decline in the future. The cumulative effects on fulmars are considered to be insignificant at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch under FMP 3.1 and FMP 3.2. 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 have potentially affected fulmar prey in the past. However, very little is known about the specific toxicological effects on species important to fulmars or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on fulmar prey availability. Pollution is likely to affect fulmar prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to fulmars, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of fulmar prey is considered to be insignificant at the population level.

Benthic Habitat

Since fulmars feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernible effect on their prey. Therefore, no cumulative effect is identified for these species.

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

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

The implementation of the new seabird avoidance measures under FMP 3.1 and FMP 3.2 would reduce the chances of taking surface-feeding species such as red-legged kittiwakes. This would likely have little effect on red-legged kittiwakes, since incidental take in the longline fisheries approaches zero under the baseline conditions. The effect of FMP 3.1 and FMP 3.2 on incidental take of red-legged kittiwakes is considered insignificant at the population level.

The incidental take of murrelets is expected to be similar to the baseline, which approaches zero. Given their nearshore preferences and less gregarious behavior, it is unlikely that murrelets would be taken regularly in any of the BSAI/GOA groundfish fisheries under FMP 3.1 or FMP 3.2. The effect of incidental take of murrelets is considered insignificant at the population level.

Changes in Food Availability

The ban on directed fisheries on forage fish would remain in place under FMP 3.1 and FMP 3.2. 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. However, the species and size classes of forage fish and zooplankton that red-legged kittiwakes consume are taken only in negligible amounts by the groundfish fisheries and their abundance and distribution are not expected to be affected on an ecosystem level by the groundfish harvest under FMP 3.1 or FMP 3.2 (see Forage Fish and Ecosystem Sections 4.7.4 and 4.7.10). 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 FMP 3.1 and FMP 3.2 on the availability of food for these species is considered insignificant on 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 FMP 3.1 or FMP 3.2 as these take place further offshore. Both FMP bookends are considered to have insignificant effects on murrelet species through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

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. 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 4.5.7.4 (Table 4.5-56) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be implemented. The incidental take of red-legged kittiwakes and both murrelets is expected to be very 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), and logging of nest trees (marbled murrelets). Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed very little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. For red-legged kittiwakes, the introduction of nest predators or a large oil spill around the Pribilof Islands in nesting season could have significant effects on mortality. For the murrelet species, oil spills in nearshore habitats and incidental take in salmon and other net fisheries are likely to remain the largest factors in the future. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may 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. Both murrelet species continue to decline in their core areas and are considered to have significantly adverse cumulative effects at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all three species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All three species prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, have likely affected the prey of these species in the past. Since murrelets are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded murrelets from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** While the groundfish fisheries are considered to have an insignificant effect on prey availability on their own, the dynamic interaction of natural and human-caused events, including fisheries and pollution, on the availability of forage fish and invertebrate prey to seabirds is only beginning to be explored with directed research. Since this dynamic could conceivably be adverse or beneficial, depending on different circumstances, the cumulative effect on prey availability is considered to be unknown for these three species.

Benthic Habitat

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. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles, but they forage in shallow waters that are inshore of the groundfish fishery. Since the groundfish fishery would contribute minimally to potential effects on benthic habitats important to murrelets, insignificant cumulative effects are identified for the murrelet species.

4.7.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

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. While this is a substantial management and fishery action and is considered an improvement relative to the baseline level of mortality, the baseline level of incidental take on longlines is already considered insignificant at the population level for gulls and alcids (Section 4.5.7.5). Incidental take in trawls would be expected to remain the same or be reduced, as a result of new scientifically based mitigation measures, relative to baseline conditions, which are considered insignificant on the population level for all piscivorous species. For these reasons, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on piscivorous species through incidental take.

Changes in Food Availability

As described in Section 4.5.7.5, the potential effects of the groundfish fishery on piscivore prey availability are considered to be insignificant under the baseline conditions. 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. Since the structure and intensity of the fishery would be very similar under FMP 3.1 and reduced under FMP 3.2, the overall effect of the fishery on the availability of food for piscivorous species is considered insignificant on the population level.

Benthic Habitat

Specific effects of trawling on seabird prey species in the BSAI/GOA (through habitat change rather than by direct take) are poorly known. 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 FMP 3.1 and reduced under FMP 3.2. The effects on piscivorous seabirds through potential changes in benthic habitat are therefore considered insignificant at the population level.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on the species in this group, including most alcids, gulls, and cormorants, are described in the species accounts of Section 3.7 (Tables 3.7-16 and 3.7-20) and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-57 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of surface-feeding piscivores (i.e. gulls) 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 trawl fleet. The incidental take all species in this group is expected to be insignificant at the population level under FMP 3.1 and FMP 3.2.

- **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 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.

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. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All species in this group prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources have likely affected the prey of these species in the past. Since some of the alcids are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded them from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is likely to affect prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute to the dynamic interaction of natural and human-caused events that affect the availability of forage fish and invertebrate prey to seabirds. While this dynamic is only beginning to be explored with directed research, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 3.1 or FMP 3.2, the cumulative effect on prey availability is considered insignificant at the population level for these species.

<u>Benthic Habitat</u>

- **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 major contributing factors are expected in the future under FMP 3.1 or FMP 3.2, the cumulative effect on benthic habitat is considered insignificant at the population level for these species.

4.7.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

Longline and trawl effort would be similar or less than baseline conditions, and new seabird avoidance measures would be expected to reduce incidental take from both longlines and trawls. The incidental take of storm-petrels and planktivorous auklets in the groundfish fisheries, through take in fishing gear and vessel strikes, is considered to be insignificant at the population level under the baseline conditions (Section 4.5.7.6). The reduced levels of take would be considered insignificant to their populations. The effects of FMP 3.1 and FMP 3.2 on incidental take of planktivorous species are considered to be insignificant at the population level.

Changes in Food Availability

As described in Section 4.5.7.6, the potential of the groundfish fishery to affect the abundance and distribution of planktonic prey through changes in predator/prey relationships is considered to be minor compared to the effects of primary productivity and oceanic fluctuations. The effect of the groundfish harvest on planktonic prey is considered insignificant to the populations of planktivorous species under the baseline conditions. Since the structure and intensity of the fishery would be similar or reduced relative to the baseline, the effect of FMP 3.1 and FMP 3.2 on prey availability for planktivores is considered insignificant on the population level.

Benthic Habitat

Storm-petrel and auklets are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish management. FMP 3.1 and FMP 3.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

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. 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 decrease under FMP 3.1 and FMP 3.2 due to new seabird protection measures and is expected to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in foreign and U.S. coastal and pelagic fisheries, oil spills and other marine pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future, except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may 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.

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 hazzards 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 also likely to affect prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute in an indirect way to human influences on planktonic prey availability, which are considered minimal compared to natural fluctuations. These cumulative effects are considered insignificant at 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.

4.7.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

Under FMP 3.1 and FMP 3.2, NOAA Fisheries would cooperate with USFWS to develop scientifically-based fishing methods that reduce incidental take of all threatened or endangered species. As described in Section 4.5.7.7, incidental take of spectacled and Steller's eider already approaches zero under the baseline conditions, so it is unlikely that new protection measures would be implemented on their behalf. Because there is no predicted overlap between the groundfish fisheries and spectacled eiders, no effect on mortality has been identified under FMP 3.1. Although there is potential for expansion of the groundfish fisheries into spectacled eider critical habitat under FMP 3.2, there would likely be minimal temporal overlap of the fishery with the presence of eiders. Therefore, the risk of incidental take would be considered insignificant. Based on the very minimal overlap between the predicted fisheries and Steller's eider habitat, which only includes the Kuskokwim Shoals area, incidental take under FMP 3.1 and FMP 3.2 will likely remain at levels approaching zero and is therefore considered to have insignificant effects on the populations of Steller's eiders through incidental take.

Changes in Food Availability

Because there is no predicted overlap between the groundfish fisheries and spectacled eiders critical habitat, no effect has been identified for food availability of spectacled eiders under FMP 3.1. Although there is a potential for expansion of the fishery into spectacled eider critical habitat under FMP 3.2, bycatch of eider prey would be negligible and considered insignificant to spectacled eiders at the population level. Since there would be very little overlap between groundfish fisheries and critical habitat for Steller's eiders under FMP 3.1 or FMP 3.2, the effects of the groundfish fisheries on prey abundance and availability are considered insignificant at the population level.

Benthic Habitat

As discussed in Section 4.5.7.7, there is no overlap between the groundfish trawl fisheries and spectacled eider habitat. FMP 3.1 is not expected to change this situation and is considered to have no effects on spectacled eiders through benthic habitat changes.

For Steller's eiders, potential trawl effort in their critical habitat is limited to Kuskokwim Shoals. No changes in management under FMP 3.1 would lead to an increase in trawl use of this area. Therefore, potential effects are likely to remain similar to the baseline condition and are considered insignificant. The overall effect of FMP 3.1 on the benthic habitat of Steller's eider is considered to be insignificant at the population level.

Under FMP 3.2, two management programs designed to conserve fish populations may actually lead to increased fishing in some eider habitats. First, the establishment of Marine Protected Areas and no-fishing zones in many areas that were fished under the baseline conditions would force the groundfish fleet to look for new areas to fish. Second, complete rationalization of the fishery would tend to give fishermen more time and opportunity to explore for new fishing grounds. It is not known whether the fishery would have the economic incentive to start fishing more heavily in the Steller's eider critical habitat in Kuskokwim Bay or to expand northward to spectacled eider critical habitat north of St. Matthew Island. It is also not known whether disturbance of benthic habitat by fishing gear in these areas would have enough impact on benthic invertebrate populations to decrease eider foraging success. Although FMP 3.2 creates conditions under which these areas may be affected by benthic habitat disturbance, the level and type of disturbance needed to create population level effects on eiders is unknown. The effects of FMP 3.2 on the benthic habitat of spectacled and Steller's eider is considered unknown.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on spectacled and Steller's eiders are described in Sections 3.7.9 and 3.7.10 (Tables 3.7-17 and 3.7-18), and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-59 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of 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 FMP 3.1 and FMP 3.2, the cumulative effects of mortality on Steller's eiders are considered significant adverse at the population level.

Changes in Food Availability

The abundance of marine invertebrate species important to 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. There is no predicted overlap between the groundfish fisheries and spectacled eider critical habitat under FMP 3.1; therefore, no cumulative effects have been identified for spectacled eiders through changes in food availability. Although many natural factors external to the fisheries may influence the abundance and distribution of eider prey, the minimal amount of spatial/temporal overlap with bottom-contact fisheries and the negligible bycatch of eider prey in these fisheries indicates that their contribution to changes in prey availability would be minimal. Therefore, insignificant cumulative effects on prey availability are identified for Steller's eiders under FMP 3.1 and FMP 3.2 and spectacled eiders under FMP 3.2.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, disrupt benthic habitats that support the prey of eiders. Under FMP 3.1, the groundfish fishery is not expected to occur in spectacled eider critical habitat or any other area that they typically use. A limited amount of bottom trawling is expected to overlap with Steller's eider critical habitat. The overall effects of FMP 3.1 on Steller's eiders through potential changes in benthic habitat are considered insignificant at the population level. There is a greater potential for the groundfish fishery to affect Steller's and spectacled eider habitats under FMP 3.2 than under FMP 3.1. However, the contribution of the fishery is considered unknown.

- **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 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 continue.

- **Cumulative Effects.** There is no predicted overlap between the groundfish fisheries and spectacled eider critical habitat under FMP 3.1 and a small potential for expansion into spectacled eider critical habitat under FMP 3.2. While the groundfish fisheries are predicted to have little spatial overlap with Steller's eider habitat under FMP 3.1 and FMP 3.2, 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 eiders are therefore considered to be unknown.

4.7.8 Marine Mammals Alternative 3 Analysis

4.7.8.1 Western Distinct Population Segment of Steller Sea Lions

FMP 3.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

The analysis used to determine changes in the level of incidental takes described in Section 4.5.8 was applied to establish the significance of incidental take and entanglement of marine mammals expected to occur under FMP 3.1. With regard to incidental take, FMP 3.1 is not likely to result in significant changes to the population trajectory of the western distinct population segment (western population) of Steller sea lions. An average of 8.4 Steller sea lions from the western population was estimated to have been taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). The ratio of observed takes of Steller sea lions to observed groundfish catch (from 1995 to 1999) was multiplied by the new projected groundfish catch (all fisheries combined) to estimate incidental takes expected to occur over the next six years under this FMP management regime. The estimated annual incidental take level of Steller sea lions under FMP 3.1 in all areas combined is expected to be fewer than 10 based on expected catch in this FMP, or about one sea lion per 220,000 mt of groundfish harvested.

The MMPA requires NOAA Fisheries (NMFS Office of Protected Resources) to assess whether human-caused mortality threatens the stability or recovery of any species of marine mammal. The MMPA defines a measurement tool for this purpose, the PBR, that is a calculated value of the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. This calculation takes into consideration the most recent population estimates, historic population trends, status of the stock in relation to historic levels (i.e., whether it is depressed or not), and potential rates of recovery. According to the most recent stock assessment, PBR for the western population of Steller sea lions is 208 animals per year (Angliss and Lodge 2002). Mortality from incidental take and entanglement in marine debris is likely to continue under FMP 3.1 at levels that are small (less than 10%) relative to PBR and is therefore considered insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

Changes in the fishing mortality rate for Steller sea lion prey species were calculated using output from the 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 Bering Sea, Aleutian Islands and GOA groundfish fisheries, the fishing mortality rates projected to occur under each FMP, and the relative difference between the baseline and alternative fishing mortality rates are shown in Table 4.5-61.

Under FMP 3.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 30 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 significant. See the discussion regarding the unusually low fishing mortality rate in 2002 (which served as the comparative baseline) in Section 4.5.9.1. The harvest of EBS pollock under FMP 3.1 management regime meets the criteria of a significantly adverse impact to Steller sea lions.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 13 percent relative to the comparative baseline over the next five years under FMP 3.1. This change in F is insignificant at the population level for Steller sea lions under the 3.1 scenario. Fishing mortality rates are not calculated for the 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 FMP 3.1 and therefore effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level for this FMP.

Under FMP 3.1, the BSAI Pacific cod fishing mortality rate is expected to increase by 19 percent. This change is determined to be insignificant to Steller sea lions according to the criteria established in Table 4.1-6. Under FMP 3.1, 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 F of 60 percent relative to the baseline under FMP 3.1.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 3.1 is expected to result in insignificant population-level effects to Steller sea lions.

<u>Spatial/Temporal Concentration of the Fishery</u>

The criterion used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations assumes that the FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive 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. Spatial and temporal measures have not been added or repealed under FMP 3.1 and the spatial/temporal concentration of the fishery is not expected to change to a large degree relative to the baseline and is therefore rated insignificant.

Disturbance

FMP 3.1 retains the area closures contained under the baseline. The management regime under FMP 3.1 is not expected to result in increased disturbance to Steller sea lions relative to the baseline. The effects of disturbance are rated insignificant under FMP 3.1.

Cumulative Effects

The past/present effects on the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above (Table 4.7-5). Representative direct effects used in this analysis include mortality and disturbance with major indirect effects of availability of prey and spatial/temporal concentration of the fisheries.

Mortality

- **Direct/Indirect Effects.** Effects of mortality from incidental take and entanglement in marine debris under FMP 3.1 are considered insignificant.

- **Persistent Past Effects.** Substantial mortality of Steller sea lions didn't occur in the fisheries until after the 1950s. The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period are not complete (Perez and Loughlin 1991). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996 to 2000. The number of Steller sea lions incidentally taken in state-managed, nearshore salmon gillnet fisheries and halibut longline fisheries was estimated at 14.5 sea lions per year in the PWS drift gillnet fisheries (Wynne *et al.* 1992). It is thought that shooting used to be a significant source of mortality prior listing the Steller sea lion as endangered under the ESA. Two cases of illegal shootings were prosecuted in the Kodiak area in 1998 and involved two Steller sea lions from the western stock (Angliss *et al.* 2001). The subsistence harvest of the western stock has decreased over the last ten years from 547 to 171 animals per year (1992 to1998) (Angliss and Lodge 2002). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). Predation by transient killer whales and sharks has always contributed to the natural mortality of Steller sea lions 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 taken will likely be relatively low (<10 per year). Entanglement and intentional shootings would also be expected to continue at a level similar to the baseline condition. Pollution is not likely a factor for this population due to the isolation from human 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.** Mortality is based on the contribution of internal effects of the groundfish fishery and external mortality effects. These effects are considered significantly adverse since the overall human-caused mortality exceeds the PBR for this population and the species is listed as endangered under the ESA due to the severe historical decline. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and, under the baseline conditions, has been considered to not cause jeopardy under the ESA (NMFS 2001b).

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of Steller sea lion prey species under FMP 3.1 is not expected to result in population-level effects, and is therefore considered insignificant.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in state waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries, perhaps in conjunction with climate and oceanographic fluctuations, greatly reduced the availability of forage fish to Steller sea lions. NMFS issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. A recent Steller sea lion BiOp and EIS (NMFS 2001b) explores this subject in great depth.

- **Reasonable Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a similar manner to the baseline condition. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects on availability of prey but the direction or magnitude of these changes are difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion.

- **Cumulative Effects.** The cumulative effect on prey availability for Steller sea lions is based on direct, indirect, and external effects on prey and is considered conditionally significant adverse. This rating is based on the adverse effects on prey availability in the past from foreign, JV, and domestic groundfish fisheries, the State-managed salmon and herring fisheries, and indications that prey availability has been a key factor in the decline of the western population over the last several decades. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine with natural fluctuations to affect prey availability such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** Spatial and temporal fishing measures under FMP 3.1 do not substantially deviate from the baseline and are considered insignificant.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of Steller Sea Lion Protection Measures, which remain in effect under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The only reasonably foreseeable future factors, external to the groundfish fisheries, that effect the spatial/temporal harvest of Steller sea lion prey would be the state-managed salmon and herring fisheries which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed in a similar manner to recent years. No new state or federal fisheries are anticipated at this time.

- **Cumulative Effects.** 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.

<u>Disturbance</u>

- **Direct/Indirect Effects.** FMP 3.1 retains the area closures set forth under the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under the FMP 3.1 management scenarios.

- **Persistent Past Effects.** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI and GOA and state-managed fisheries. Past disturbances was also identified from commercial harvest, intentional shooting and subsistence harvest. General vessel traffic and disturbance of prey fields from fishing gear have also regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future disturbance was identified for state-managed salmon and herring fisheries as well as general fishing and non-fishing vessel traffic in Steller sea lion foraging areas. Subsistence harvest was also identified as a continuing source of disturbance to Steller sea lions. Level of disturbance is expected to be similar to baseline conditions.

- **Cumulative Effects.** Disturbance to Steller sea lions is based on contributions from both internal and external effects. The cumulative effect was considered insignificant because it is similar to the baseline condition and population-level effects are unlikely.

Direct/Indirect Effects – FMP 3.2

Incidental Take/Entanglement in Marine Debris

Effects are expected to be insignificant as described under FMP 3.1 for the western population of Steller sea lions.

Fisheries Harvest of Prey Species

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 FMP, and the relative difference between the baseline and fishing mortality rates under each FMP are shown in Table 4.5-61.

Under FMP 3.2, 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 of this key Steller sea lion prey species is considered to be significant. See the discussion regarding the unusually low fishing mortality rate in 2002 (which served as the comparative baseline) in Section 4.5.8.1. The harvest of EBS pollock under the FMP 3.2 management regime meets the criteria of a significantly adverse impact to Steller sea lions.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 29 percent relative to the comparative baseline over the next five years under FMP 3.2. This change in fishing mortality rate is rated as significantly beneficial under the FMP 3.2 scenario at the population level for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 3.2, therefore effects of Aleutian Island pollock harvests are deemed to be insignificant to Steller sea lions at the population level for this FMP.

Under FMP 3.2, the BSAI and GOA Pacific cod fishing mortality rates are expected to increase by 17 percent and six percent 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 also expected to be insignificant to Steller sea lions under FMP 3.2, with a projected increase in fishing mortality rate of 14 percent relative to the baseline. The nearshore area closures under FMP 3.2 would require a significant spatial redistribution of Aleutian Islands Atka mackerel fishing effort. Under baseline conditions, approximately 43 percent of Aleutian Islands Atka mackerel were caught in areas that would be closed under FMP 3.2. Although the target species model projects a fishing mortality rate of 0.28, this rate may not be sustainable over five years in the limited area where the fishery would be displaced. According to the significance criteria in Table 4.1-6, harvest of Aleutian Islands Atka mackerel under FMP 3.2 would be insignificant to the western population of Steller sea lions under the worst case scenario and would be conditionally significant beneficial if the overall fishing mortality rate decreased due to the offshore displacement of the fishery.

Little difference is expected relative to the baseline and among the FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions.

The combined harvest of Steller sea lion prey species under FMP 3.2 is expected to decrease overall relative to the baseline and therefore result in insignificant population-level effects to Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The criterion used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations is that the FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. The spatial/temporal measures in FMP 1 (and retained throughout all of the FMPs) were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where Steller sea lions are known to occur. Under the baseline condition, 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 condition, 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. FMP 3.2 offers opportunities for additional temporal and spatial protection. Under FMP 3.2, a buffer out to15 nm from shore would offer increased protection 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 condition and have the potential to provide beneficial effects to Steller sea lions. As these effects cannot be quantified, they are determined to be conditionally significant beneficial to Steller sea lions based on the assumption that they may result in improvements to the prey field to the extent that population-level effects could occur.

Disturbance

Effects of disturbance are considered insignificant as described under 3.1.

Cumulative Effects

The past/present effects on the western population Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 3.2 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative sense . This analysis seeks to provide an overall assessment of the species' population-level response to its environment as it is influenced by the groundfish fishery. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, FMP 3.2 is not likely to result in significant changes to the population trajectory of the western population of Steller sea lions.

- **Persistent Past Effects.** Past effects of mortality are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects of mortality are the same as discussed under FMP 3.1.

- **Cumulative Effects.** Cumulative effects on mortality are based on the contribution of internal effect of the groundfish fishery and external mortality effects. This effect is considered significantly adverse since the overall human-caused mortality exceeds the PBR for this population, the species is listed as endangered under the ESA due to the severe decline of the species. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and has been considered to not cause jeopardy under the ESA (NMFS 2001b).

Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.2, the combined harvest of Steller sea lion prey species is expected to result in insignificant population-level effects to Steller sea lions.

- **Persistent Past Effects.** Past effects are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects are the same as discussed under FMP 3.1.

- **Cumulative Effects.** The cumulative effect on prey availability for Steller sea lions is based on direct, indirect, and external effects on prey and is considered conditionally significant adverse. This rating is based on the adverse effects on prey availability in the past from foreign, JV, and domestic groundfish fisheries, the State-managed salmon and herring fisheries, and indications that prey availability has been a key factor in the decline of the western population over the last several decades. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine with natural fluctuations to affect prey availability such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Spatial/Temporal Effects of Harvest

- **Direct/Indirect Effects.** Effects under FMP 3.2 are determined to be conditionally significant beneficial to Steller sea lions based on the assumption that they may result in improvements to the prey field to the extent that population-level effects could occur.

- **Persistent Past Effects.** Past effects are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects are the same as discussed under FMP 3.1.

- **Cumulative Effects.** Effects of the spatial/temporal harvest of prey were identified as cumulative based on both internal past effects on the groundfish fishery and state-managed fisheries. These effects were considered conditionally significant beneficial based primarily on the internal effects of the FMP. Under FMP 3.2, Steller sea lion protection measures would be extended to a buffer out to15 nm from shore that would offer increased protection in areas determined to be important for Steller sea lions. This rating is conditional based on whether displacing fisheries offshore would result in actual improvements to the prey field to the extent that beneficial population-level effects occur.

Disturbance

- **Direct/Indirect Effects.** FMP 3.2 retains the area closures contained under the baseline and expands the closed buffer areas along the shoreline to 15 nm (outside of MPA or no take reserves). However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 3.2 management scenarios.

- **Persistent Past Effects.** Past effects of disturbance are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects of disturbance are the same as discussed under FMP 3.1.

- **Cumulative Effects.** Disturbance to Steller sea lions is based on contributions from both internal and external effects. Cumulative effects are considered insignificant because disturbance would decrease from the baseline condition and population-level effects are unlikely.

4.7.8.2 Eastern Distinct Population Segment of Steller Sea Lions

FMP 3.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 3.1 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 incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). In this context, incidental take refers to animals which are deceased or have injuries that are expected to result in the death of the animal. Because no animals from the eastern population have been taken incidental to groundfish fisheries, changes in catch resulting from FMP 3.1 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, and does not appear to represent a significant threat to the population. In conclusion, incidental take and entanglement in marine debris under

FMP 3.1 are expected to be similar to the baseline condition and are 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 prey availability for the eastern population of Steller sea lions as there is little overlap between this population and fisheries that harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to have an effect on the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock and Pacific cod under FMP 3.1 are expected to decrease by 13 percent and increase by 19 percent, respectively, relative to the comparative baseline over the next five years. The fishing mortality rates under FMP 3.1 are therefore rated insignificant for GOA pollock and Pacific cod harvests.

Little difference is expected relative to the baseline and among the FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 3.1 is expected to be similar to the baseline condition and is expected to have insignificant effects on the eastern population of Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The criteria used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations assumes that the FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would occur. The spatial/temporal measures in the baseline (and retained throughout all of the FMPs) were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where Steller sea lions are known to occur. Under the baseline condition, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as "global controls." Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the eastern population of Steller sea lions in the wild. Spatial and temporal measures have not been added or repealed under FMP 3.1 so that the spatial/temporal concentration of the fishery is not expected to change significantly relative to the baseline and is therefore rated insignificant.

Disturbance

FMP 3.1 retains the area closures contained under the baseline. The management regime under FMP 3.1 is not expected to result in increased disturbance to Steller sea lions relative to the baseline and is therefore rated to have insignificant effects.

Cumulative Effects

The past/present effects on the eastern population of the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 3.1are described above. The effects considered in this analysis are listed in Table 4.5-63. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects including availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

<u>Mortality</u>

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, FMP 3.1 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. NMFS 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 from the eastern population of the Steller sea lion is very small and is subject to an average of only 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. Intentional shooting of Steller sea lions, other than in subsistence hunts, became illegal after the species was listed as threatened under the ESA in 1990. It is thought that shooting used to be a significant source of mortality prior to that time. Steller sea lions are incidentally taken in low numbers by commercial fisheries other than groundfish fisheries, including some state-managed salmon drift and set gillet fisheries, 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 also taken outside of southeast Alaska in groundfish fisheries (0.45 per year in Washington, Oregon and California) and set gillet fisheries in northern Washington (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 10 percent of the PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillet and troll fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely relatively low (<10 per year). Groundfish fisheries in Washington, Oregon and California and salmon set gillnets fisheries will continue to take small numbers from this population. Entanglement and intentional shootings would also be expected to continue. Pollution is likely more of a factor for this population due to its proximity to population centers. Climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Effects of mortality are based on the contribution of internal effects of the groundfish fishery and external mortality effects. This effect is 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, it has been increasing over the last 20 years. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and has been determined to not cause jeopardy under the ESA (NMFS 2001).

<u>Effects of Prey Availability</u>

- **Direct/Indirect Effects.** The combined harvest of the eastern population of Steller sea lion prey species under FMP 3.1 is not expected to result in population-level effects and is considered insignificant.

- **Persistent Past Effects.** Past effects on key prey species of the eastern population of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. NMFS issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. A recent Steller sea lion BiOp and EIS (NMFS 2001b) 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 similar manner to the baseline condition. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects of availability of prey but the direction or magnitude of these changes is difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion, but effects of climate change or regime shifts on the eastern population of the Steller sea lion are largely unknown.

- **Cumulative Effects.** The cumulative effects of prey availability on the eastern population of the Steller sea lion are considered to be insignificant at the population level. The eastern population of Steller sea lions has been increasing steadily over the last 20 years so prey availability is not considered to be limiting the recovery of the population.

<u>Spatial/Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects.** Spatial and temporal fishing measures under FMP 3.1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries are determined to be insignificant to Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of the baseline Steller sea lion protective measures.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon set and drift net gillet fisheries and salmon troll fisheries and herring fisheries are expected to continue in future years in a similar manner to the baseline conditions.

- **Cumulative Effects.** Cumulative effects for the spatial and temporal harvest of prey from both internal effects of the groundfish fishery and external effects such as state-managed fisheries are likely to remain similar to the baseline condition, under which the population has increased steadily, and is therefore considered insignificant for the eastern population of Steller sea lions.

Disturbance

- **Direct/Indirect Effects.** The effects of disturbance on Steller sea lions under the FMP 3.1 are expected to be similar to the baseline and population-level effects are unlikely. Therefore, cumulative effects are considered insignificant. Protection measures around rookeries and haulouts limit disturbance and will continue under FMP 3.1.

- **Persistent Past Effects.** Past disturbance was identified for foreign, JV, and federal domestic groundfish fisheries and state-managed salmon and herring fisheries. General vessel traffic has also contributed to the disturbance level for this population. Intentional shooting has likely been a 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 condition. Disturbance from subsistence harvest is not a foreseeable effect for this population.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external sources is likely to remain similar to the baseline condition, under which the population has increased steadily, and is therefore considered insignificant.

Direct/Indirect Effects FMP 3.2

Incidental Take/Entanglement in Marine Debris

Effects are the same as described under FMP 3.1 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 between this population and fisheries that 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 FMP 3.2 are expected to decrease 29 percent relative to the comparative baseline over the next five years. Average fishing mortality rates of GOA Pacific cod under FMP 3.2 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 FMP 3.2 are insignificant for GOA Pacific cod harvests and significantly beneficial for GOA pollock.

Little difference is expected relative to the baseline and among the FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 3.2 is expected to result in insignificant population-level effects on Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal measures under the baseline conditions were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where sea lions are known to occur. Under the baseline condition, 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. FMP 3.2 offers opportunities for additional temporal and spatial protections. Under FMP 3.2 all areas would have a 15 nm buffer from shore 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, since the eastern population of Steller sea lions has been increasing steadily over the past 20 years and food availability does not appear to be limiting their population recovery, it is unlikely that these additional protection measures would improve their access to prey to the extent that population-level effects would occur. While the spatial/temporal measures under FMP 3.2 could be considered beneficial, they are unlikely to result in substantial changes to the baseline condition and are therefore considered insignificant at the population-level for the eastern population of Steller sea lions.

Disturbance

Effects do not deviate from those described under the FMP 3.1 and are considered insignificant.

Cumulative Effects

For the eastern population of Steller sea lions, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

4.7.8.3 Northern Fur Seals

Direct/Indirect Effects FMP 3.1

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, incidental takes and entanglements of northern fur seals expected to occur incidental to groundfish fisheries under FMP 3.1 are not expected to result in population-level effects. Increased harvest rates under this management alternative are not large enough for expected take levels to change relative to the baseline (see section 4.5.8.3) and is therefore rated insignificant under FMP 3.1.

Fisheries Harvest of Prey Species

Under FMP 3.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 30 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, this change in the harvest of adult pollock, which is a key prey species of northern fur seals in the EBS, is rated significantly adverse. 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 unusually low fishing mortality rate of EBS pollock in 2002 in Section 4.5.8.1).

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).

Therefore, 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 FMP 3.1.

While the potential overlap with fisheries may be moderated by these factors, effects on northern fur seals may yet exist, the relevance of which is not reflected by estimates of biomass removals over large geographical areas. The potential for competitive overlap between northern fur seals and groundfish fisheries may be tempered by the spatial and temporal distribution of the harvest. These effects are analyzed under the “Spatial/Temporal” heading. Fisheries may also trigger trophic level effects which may affect the availability of northern fur seal prey and these effects are discussed in the ecosystem section.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 3.1 are determined to be insignificant to northern fur seals as they do not deviate from the spatial/temporal measures under the baseline conditions. However, effects to northern fur seals from spatial/temporal concentration of the fisheries under the strategy defined as the baseline for this environmental analysis were rated conditionally significant adverse in the Steller sea lion SEIS (NMFS 2001b). Therefore, while the spatial/temporal effects of FMP 3.1 are insignificant relative to the baseline, the baseline has been described as having potential adverse effects on northern fur seals.

Disturbance

Disturbance of northern fur seals under the FMP 3.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

Cumulative Effects

A summary of the past/present effects with regard 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 FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-64. Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey an spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With respect to mortality and entanglement in marine debris, the effects on the northern fur seal under FMP 3.1 are rated insignificant.

- **Persistent Past Effects.** Persisting effects of past mortality include commercial harvest of young males up to 1985, harvest of females between 1956 and 1968, incidental take in the JV and 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 seals on the Pribilof Islands, as many as 300,000 between 1956 and 1968, likely contributed to the decline of the population in the late 1970's and early 1980's (York and Kozloff 1987). This precipitous decline resulted in the depeleted 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 numbers have steadily declined (NMFS 1993, Angliss and Lodge 2002). The contribution of the earlier harvest of fur seals to the subsequent decline is uncertain. It has been nearly 20 years since commercial harvest was ended. Subsistence harvest has 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 the 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 seals are widely dispersed. State-managed fisheries take small numbers of fur seals, including the PWS drift gillet fishery, Alaska Peninsula and Aleutian Island salmon gillet 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, but levels of take are expected to remain well below 10 percent of the PBR for this species. Short-term and long-term climate change is not considered a major mortality factor for this species.

- **Cumulative Effects.** Cumulative effects of mortality from internal and external factors are considered insignificant. The contribution of the groundfish fisheries is very small and approaches zero. The effect is insignificant because of the size of the fur seal population in relation to existing levels of take, which are well below the PBR of this species. Population-level effects are not anticipated.

<u>Availability of Prey</u>

- **Direct/Indirect Effects.** The effects of the groundfish fisheries on prey availability for northern fur seals under FMP 3.1are rated insignificant.

- **Persistent Past Effects.** Effects of groundfish harvest of prey species in the past have likely occurred from overlap of particular prey species and fish targeted by the foreign and JV fisheries in the BSAI, as well as the state and federal fisheries. Climate and oceanic fluctuations are also suspect in past changes to the abundance and distribution of prey.

- **Reasonably Foreseeable Future External Effects.** Effects on prey availability in the future may result from overlap in prey species with state-managed fisheries in nearshore areas and effects of climate change/regime shifts may also affect 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.

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

- **Direct/Indirect Effect.** The effects of the spatial/temporal concentration of the fisheries under FMP 3.1 are determined to be insignificant to northern fur seals as they do not deviate from the spatial/temporal measures under the baseline conditions.

- **Persistent Past Effects.** Effects of past fisheries harvest of prey are primarily from the foreign and JV fisheries and the state and federal domestic fisheries in the BSAI. There has been concern in regard to fishing effort being displaced offshore with the recent restrictions in the SSL Protection Measures, resulting in increased overlap with fur seal foraging area. The proportion of the total June-October pollock catch in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is particular concern for the potential impact of this increased fishing pressure on lactating females from St. George Island where catch rates were consistently higher than in areas used by females from St. Paul. However, the competitive overlap is minimized by several factors including prey size and prey species of the fur seal.

- **Reasonably Foreseeable Future External Effects.** Effects of the spatial/temporal harvest of prey species exist primarily in the foreign and Federal domestic fisheries outside the EEZ, due to the extensive range of fur seals when they are away from their breeding rookeries. State-managed fisheries have very limited overlap with fur seal prey. Climate change was also identified as a potential factor in spatial/temporal effects on prey.

- **Cumulative Effects.** The cumulative 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.

<u>Disturbance</u>

- **Direct/Indirect Effect.** Disturbance of northern fur seals under the FMP 3.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

- **Persistent Past Effects.** Past disturbance of fur seals has comes from 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 exert persistent effects in the present but the ongoing fisheries do continue to result in some level of disturbance to fur seals while they are in the BSAI region.

- **Reasonably Foreseeable Future External Effects.** 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– FMP 3.2

For northern fur seals, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and disturbance are the same as discussed under FMP 3.1.

Spatial/Temporal Concentration of the Fishery

FMP 3.2 offers opportunities for additional temporal and spatial protections relative to baseline conditions and may be more precautionary from the standpoint of prey available to northern fur seals. Under FMP 3.2, all areas would be buffered out to 15 nm from shore which may offer increased protection to northern fur 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 northern fur seals. Because these effects cannot be quantified they are determined to be conditionally significant beneficial to northern fur seals based on the assumption that they may result in improvements to the prey field to the extent that population-level effects could occur.

Cumulative Effects

For northern fur seals, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

Spatial/Temporal Concentration of Harvest

- **Direct/Indirect Effects.** Effects of groundfish fisheries under FMP 3.2 on the spatial/temporal concentration of fisheries harvest are reduced compared to the baseline conditions; thus the effects of the spatial/temporal concentration of harvest under FMP 3.2 are determined to be conditionally significant beneficial to northern fur seals.

- **Persistent Past Effects.** Past effects of spatial/temporal concentration of fisheries harvest are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects are the same as discussed under FMP 3.1.

- **Cumulative Effects.** The cumulative effects of spatial/temporal harvest of prey, based on the presence of internal and external factors, are considered conditionally significant beneficial to northern fur seal populations. The significance rating is based on the reduction of spatial/temporal overlap with the groundfish fisheries and the increased protection with MPAs and shoreline buffers. The rating is conditional on whether the concentration of the fisheries was a factor in the past population decline and whether measures implemented under FMP 3.2 actually have beneficial population-level effects on northern fur seals.

4.7.8.4 Harbor Seals

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, takes and entanglements of harbor seals expected to occur incidental to groundfish fisheries under FMP 3.1 are not expected to result in population-level effects. Increased harvest rates under this management alternative may result in the increased take of 1 harbor seal relative to the baseline, for a total estimated average of fewer than 5 animals per year. This level of incidental take would not result in changes to the population trajectory for this species. Therefore, takes and entanglements of harbor seals incidental to groundfish fisheries are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Under FMP 3.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 30 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key harbor seal prey species is rated significant (see the discussion regarding the comparative baseline fishing mortality rate in Section 4.5.8.1.). 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 13 percent under FMP 3.1 relative to the comparative baseline over the next 5 years and is considered insignificant. Under FMP 3.1, the BSAI Pacific cod fishing mortality rate is expected to increase 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 3.1 bookend are expected to be significantly adverse to harbor seals with a 60 percent increase in fishing mortality rate relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for harbor seals (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to harbor seals. The combined harvest of harbor seal prey species under FMP 3.1 is expected to be similar to the baseline and result in insignificant population-level effects overall.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 3.1 are determined to be insignificant to harbor seals as they do not deviate from the spatial/temporal measures under the baseline conditions.

Disturbance

Disturbance of harbor seals under FMP 3.1 is not expected to increase relative to the baseline and is therefore rated insignificant.

Cumulative Effects

A summary of the effects of the past/present with regards to the harbor seal is presented in Section 3.8.4 (Table 3.8-4). The predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-65. Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Incidental takes and entanglements of harbor seals expected to occur in groundfish fisheries under FMP 3.1 are not expected to result in population-level effects, therefore they are considered insignificant.

- **Persistent Past Effect.** Residual effects on local populations of State predator control programs (1950s to 1972) and commercial hunts (1963 to 1972) may persist in some areas although there are no data on these factors. Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear but based on the near shore distribution of harbor seals, there was likely minimal direct interaction and mortality is believed to have been very low. From 1990 to 1996, minimum estimates of harbor seals taken incidentally in groundfish gear in the Bering Sea were 4 per year and fewer than 1 per year in the GOA. In southeast Alaska, 4 harbors seals are estimated to be killed each year on longlines. Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide subsistence harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which were taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). Harvest of 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 seals in state-managed fisheries such as salmon set and drift gillet fisheries would be expected to continue at its present low rate. Subsistence take is expected to continue to be the greatest source of human controlled mortality with a relatively high percentage of the PBR in both the GOA and southeast Alaska stock and a lower take in the BSAI region. Climate change is likely not a factor in the direct mortality of harbor seal although there would likely 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 FMP 3.1 is not expected to result in population-level effects and is considered insignificant.

- **Persistent Past Effects.** Availability of prey for harbor seals in the past has likely been affected by foreign and JV fisheries, federal domestic groundfish fisheries, and state-managed salmon and herring fisheries since the fish targeted by these fisheries are also prey for the harbor seal. Climate change/regime shift could possibly have been a factor in fluctuations in prey availability in the past.

- **Reasonably Foreseeable Future External Effects.** State-managed salmon and herring fisheries are identified as having potential adverse effects on harbor seal prey availability. Climate change/regime shift will continue to be a contributing factor although the effects can be beneficial or adverse, depending on the direction and magnitude of 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/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentration of the fisheries under FMP 3.1 are rated insignificant to harbor seals.

- **Persistent Past Effects.** Effects of groundfish harvest in the past have likely occurred from overlap between harbor seal prey species, types of fish targeted, and areas fished by the foreign and JV fisheries in the BSAI, as well as state and federal fisheries. Climate and oceanic fluctuations are not considered factors in past changes to the spatial/temporal harvest of harbor seal prey species.

- **Reasonably Foreseeable Future External Effects.** Future effects of spatial/temporal harvest on harbor seal populations may result from overlap between prey species and the state-managed fisheries in nearshore areas such as salmon and herring. Climate change/regime shifts may also affect prey species abundance and distribution. Since these fisheries generally occur in the nearshore areas in comparison to groundfish fisheries, overlap is more prevalent compared to the groundfish fisheries.

- **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 Effect.** The effects of disturbance on harbor seals are considered to be insignificant at the population-level.

- **Persistent Past Effects.** Past disturbance of harbor seals may have resulted from groundfish fisheries including JV fisheries, foreign and federal domestic fisheries, and to a lesser extent the subsistence harvest of harbor seals. It is unknown whether these past effects persist but the ongoing fisheries activities and subsistence harvests continue to result in some level of disturbance to harbor seal populations.

- **Reasonablely Foreseeable Future External Effects.** State-managed fisheries, general vessel traffic, and subsistence activities would be expected to continue and may create some level of disturbance to harbor seals in the foreseeable future.

- **Cumulative Effects.** Cumulative effects of disturbance on harbor seal populations are expected to be similar to the baseline conditions and are considered insignificant.

Direct/Indirect Effects FMP 3.2

For harbor seals, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and disturbance are the same as discussed under FMP 3.1.

<u>Spatial/Temporal Concentration of the Fishery</u>

The FMP 3.2 bookend offers opportunities for additional temporal and spatial protections relative to baseline conditions and may be more precautionary from the standpoint of prey available to harbor seals. Under FMP 3.2 all areas would be buffered out to 15 nm from shore in areas not covered by MPAs or no-take preserves, which would 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. Because these effects cannot be quantified they are determined to be conditionally significant beneficial to harbor seals based on whether they actually result in improvements to the prey field to the extent that beneficial population-level effects occur.

Cumulative Effects

For harbor seals, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

<u>Spatial/Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects.** FMP 3.2 offers opportunities for additional temporal and spatial protections relative to baseline conditions and may be more precautionary from the standpoint of prey availability to harbor seals. These effects are determined to be conditionally significant beneficial to harbor seal populations.

- **Persistent Past Effects.** Past effects of spatial/temporal concentration of fisheries are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects of spatial/temporal concentration of fisheries are the same as discussed under FMP 3.1.

- **Cumulative Effects.** Overall, cumulative effects of spatial/temporal harvest of prey are determined to have potentially beneficial effects on the prey fields of harbor seals due to displacement of groundfish fisheries offshore (15 nm shoreline buffer). These effects are considered conditionally significant beneficial based on whether they actually result in improvements to prey fields to the extent that beneficial population-level effects occur.

4.7.8.5 Other Pinnipeds

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

Due to the low level of documented interactions between other pinnipeds and groundfish fisheries (see Section 4.5.8.5), takes and entanglements of other pinnipeds incidental to groundfish fisheries under FMP 3.1 are expected to be similar to the baseline condition, unlikely to cause population-level effects on any species, and considered insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The effects of fisheries harvests on ice seal prey species are insignificant under the baseline due to limited overlap (see Section 4.5.8.5). The effects of fisheries harvest under FMP 3.1 are expected to be similar to the baseline condition and are therefore determined to be insignificant to ice seals.

With regard to Pacific walrus, their diet is composed almost exclusively of benthic invertebrates (97 percent), particularly bivalve molluscs. Fish ingestion has been considered incidental to their normal feeding behavior (Fay and Stoker 1982). Groundfish removals under FMP 3.1 would have an insignificant effect on walrus prey availability.

The diet of northern elephant seals in the GOA is unknown; however, the species is known to be a deep diver. This behavior suggests that their foraging may be partitioned by depth from most groundfish fishing activities. The effects of groundfish harvests on prey species for northern elephant seals are therefore considered to be unknown under FMP 3.1.

Spatial/Temporal Concentration of the Fishery

Due to the limited potential for competitive overlap to occur, the spatial/temporal concentrations of the groundfish fisheries are expected to be inconsequential to pinnipeds in this category under FMP 3.1.

Disturbance

Disturbance of other pinnipeds under the FMP 3.1 management regime is not expected to change relative to the baseline, which is considered of negligible effect, and is therefore rated insignificant.

Cumulative Effects

A summary of the effects of the past/present with regards to other pinnipeds is presented in Section 3.8.3 and 3.8.5 through 3.8.9 (Table 3.8-3 and Tables 3.8-5 through 3.8-9). The predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above. Cumulative effects are summarized in Table 4.5-66.

Mortality

- **Direct/Indirect Effects.** Population-level effects are not expected to result from incidental take and entanglement for any of the species in this group under the FMP 3.1 and are rated as insignificant.

- **Persistent Past Effects.** Past external effects on the populations of pinniped include low levels of incidental take in the foreign, JV, and domestic groundfish fisheries and low levels of take in the State-managed fisheries. Spotted seal incidental mortality in groundfish fisheries is one per year between 1995 and 1999 (Angliss and Lodge 2002). For bearded seal, the BSAI groundfish fisheries take an average of 0.6 per year. The Bristol Bay salmon drift gillet fishery from 1990-1993 indicated that 14 mortalities and 31 injuries of bearded seal. No mortalities of ringed seal have been observed in the last ten years in the BSAI groundfish (Angliss *et al.* 2001). For ribbon seal incidental take, the Bering Sea trawl fishery reported one taken in 1990, one in 1991, and one in 1997. An average of 86 elephant seals is taken each year in various gillet fisheries from California to Washington. Incidental take included one in the Bering Sea trawl fishery in 1990, two in the GOA trawl fishery in 1990, and three in the GOA longline fishery in 1990. One juvenile elephant seal, originally misidentified as a bearded seal, was taken in the Bering Sea trawl fishery in 1991 (Angliss *et al.* 2001). Of the 17 Pacific walrus that were caught each year in groundfish trawl fisheries in the EBS between 1990 and 1997, over 80 percent were already decomposed (Gorbics *et al.* 1998). Subsistence is the major human-cause external factor for morality. Annual subsistence harvest rates include 5,265 spotted seal, 6,788 bearded seal, 100 ribbon seal, 9,567 ringed seal, 1,000 walrus and zero elephant seal.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries will likely continue to take very small numbers of seals in this group. Subsistence take of these marine mammals will likely continue at a similar rate to the baseline conditions.

- **Cumulative Effects.** The 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 FMP 3.1.

- **Persistent Past Effects.** Past effects 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.

- **Reasonably Foreseeable Future External Effects.** Future effects were identified for State-managed fisheries for the spotted seal. Climate change may be either a beneficial factor or adverse factor for the ice seals due to the potential effects on the extent of ice cover in the Bering Sea and effect on abundance and distribution of prey.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance of prey for pinnipeds is considered insignificant for all species. Spotted seals have some overlap of prey with the groundfish fisheries but the harvest of prey by the fisheries is not expected to have population level effects. The amount of groundfish fishery overlap with elephant seals is unknown but, since the elephant seal population is expanding, food does not appear to be limiting so cumulative effects on prey availability are considered insignificant. The amount of prey overlap with the other pinniped species is very limited and is considered insignificant for all species in this group.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** The effects from spatial/temporal concentrations of the fisheries are expected to be insignificant for pinnipeds in this category under FMP 3.1.

- **Persistent Past Effects.** Persistent past effects on spotted seals include foreign, JV, and domestic groundfish fisheries and state-managed fisheries. For other species, no past effects are identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries within the range of spotted seals would be expected to take place in the future in a manner similar to the baseline conditions. Future effects of spatial/temporal concentration of fisheries on ice seals and walrus would not be expected.

- **Cumulative Effects.** The spatial/temporal concentration of the groundfish fishery and all other fisheries is considered to have an insignificant cumulative effect on pinniped prey due to limited seasonal overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects.** Similar levels of disturbance to the baseline are expected under FMP 3.1 and are considered insignificant.

- **Persistent Past Effects.** Past sources of disturbance for spotted seals have come from the foreign and JV fisheries, federal domestic groundfish fisheries in the BSAI, and state-managed fisheries for salmon. Overlap of fisheries is minimal for most species. The primary source of external disturbance to the "other pinniped" category would be related to 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 baseline conditions as well.

- **Cumulative Effects.** Cumulative effects of disturbance were determined insignificant for all species based on very limited overlap with the fisheries and the lack of evidence that disturbance has a population-level effect on any of these species.

Direct/Indirect Effects – FMP 3.2

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 FMP 3.1.

Cumulative Effects

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 under FMP3.2 are the same as discussed under FMP 3.1.

4.7.8.6 Transient Killer Whales

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

Increased harvest rates under this management alternative may result in the increased take of less than one killer whale relative to the baseline, for a total estimated average of fewer than 2 animals per year. It is not known what proportion of these whales were transients versus residents but it is likely that most takes have been resident killer whales since they feed on fish and would be more attracted to fishing activities. The expected level of take would not result in changes to the population trajectory of transient killer whales. Therefore, takes and entanglements of transient killer whales incidental to groundfish fisheries under FMP 3.1 are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The diet of transient killer whales consists of marine mammals. Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant under FMP 3.1.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant under FMP 3.1.

Disturbance

FMP 3.1 retains the area closures contained in the baseline. The management regime under FMP 3.1 is not expected to result in increased disturbance to killer whales relative to the baseline and is rated insignificant.

Cumulative Effects

The past/present effects on transient killer whales are described in Section 3.8.22 (Table 3.8-22) and the predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-67. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects being availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, FMP 3.1 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 fisheries, domestic groundfish fisheries, state-managed fisheries, and intentional shootings. Past incidental take in the groundfish fisheries is less than 2 animals per year, but its not known if these animals were transients or residents. In addition to mortalities caused by entanglement, killer whales are also susceptible to injury or mortality through vessel strikes. One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002). The EVOS resulted in the loss of half of the individual killer whales from the AT1 pod in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and 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 their subsequent population decline.

Prey Availability

- **Direct/Indirect Effect.** Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant.

- **Persistent Past Effects.** Since marine mammals are the primary prey of transient killer whales, all of the factors that have been identified as affecting the abundance or distribution of cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include commercial and subsistence harvest, intentional shootings, incidental take in all fisheries, marine pollution, climate change, and regime shifts. In addition, there is the potential for past indirect effects of fisheries on the abundance of Steller sea lions, fur seals, and harbor seals, all of which are important prey species for transient killer whales. Declines in harbor seals in PWS after the EVOS could have affected the AT1 group of transient killer whales through their food supply (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey species important to transient killer whales, primarily marine mammals, would include state-managed fisheries to a small extent and subsistence harvests of the various marine mammals.

- **Cumulative Effects.** The cumulative effects on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may specialize on particular prey species, the ability of these top predators to switch prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey. The overall availability of prey does not appear to be having population level effects on transient killer whales and therefore the cumulative effect is considered insignificant.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant.

- **Persistent Past Effects.** All persistent past effects that have been identified for cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include the potential contribution of the spatial/temporal concentration of past fisheries to have caused localized depletion of prey for Steller sea lions, harbor seals, and northern fur seals with consequent population-level effects on those species.

- **Reasonably Foreseeable Future External Effects.** The future spatial/temporal concentration of external fisheries could have indirect effects on the abundance and distribution of marine mammals that are important prey for transient killer whales.

- **Cumulative Effects.** The cumulative effects of the spatial/temporal concentration of fisheries on different marine mammal species result in changes to the abundance and distribution of prey to transient killer whales. Since transient killer whales. are able to switch prey and forage over vast areas, the potential localized depletion of any one species or stock of marine mammal prey is unlikely to have population level effects on the killer whales. The cumulative effect of the spatial and temporal harvest of fish from all fisheries does not appear to be having population level effects on transient killer whales and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance to killer whales are expected to be similar to baseline conditions and are insignificant.

- **Persistent Past Effects.** Some levels of disturbance have likely occurred from foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Vessel traffic external to the fisheries has also contributed to overall disturbance of these animals. Effects of the level of disturbance on transient killer whales are largely unknown.

- **Reasonably Foreseeable Future External Effects.** External effects of state-managed fisheries and other vessel traffic on disturbance will likely occur in future years at a level similar to the baseline.

- **Cumulative Effects.** Cumulative effects of disturbance to transient killer whales are not likely to result in any population-level effects and are therefore considered insignificant.

Direct/Indirect Effects – FMP 3.2

For transient killer whales, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under FMP 3.1.

Cumulative Effects

For transient killer whales, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

4.7.8.7 Other Toothed Whales

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 3.1 is not likely to result in significant changes to the population trajectories of toothed whales. Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels thought to be insignificant to toothed whale populations (see section 4.5.8.7).

Fisheries Harvest of Prey Species

The effects of the groundfish fisheries on the toothed whales are largely constrained by differences between their prey items and the target species of the fisheries harvest (see Section 4.5.8.7). FMP 3.1 is not expected to increase the level of interactions above the baseline condition and is therefore determined to be insignificant at the population level.

Spatial/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 FMP 3.1 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 FMP 3.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

Cumulative Effects

The past/present effects on the other toothed whale group are described in Sections 3.8.19 through 3.8.21 and 3.8.23 through 3.8.25 (Tables 3.8-19 through 3.8-25) and the predicted direct/indirect effects of the groundfish fishery under the FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-68. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Toothed whale mortality resulting from groundfish fishing activities is rare and is not expected to affect the population trajectories of any of these species. Therefore, it is considered 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 under by hunters from Native Village of Tyonek and one beluga was harvest in 2002 by the Cook Inlet community hunters. Belugas are incidentally taken the State-managed salmon gillet fisheries in Bristol Bay and Cook Inlet. However, one beluga was reported to be taken from the eastern Bering stock in 1996 and 7 were reported taken in Bristol Bay in 2000. In the BSAI and GOA groundfish fisheries, no mortality or serious injuries to belugas have been observed. Harbor porpoise have not been taken in the observed groundfish fisheries over a ten year period between 1990 to 1998 (Angliss *et al.* 2001). Salmon gillet fisheries in southeast Alaska take approximately 3 individuals per year. Dall porpoise mean annual mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery. The Alaska Peninsula/Aleutian Island salmon drift gillet fishery has a higher take of Dall's Porpoise with an estimated 28 porpoises in one year (1990). Thousands of Pacific white-sided dolphins were killed annually between 1978 and 1991 in the high seas driftnet fisheries, which no longer occurs (Angliss *et al.* 2001). One Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery during the same time span (Angliss *et al.* 2001). State-managed salmon gillet fisheries take approximately 2 dolphins per year.

Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 with the highest counts occurring in 1968 when 16,357 sperm whales were harvested after which the population were severely depleted. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. Sperm whale have been known to prey on sablefish caught on commercial longline gear in the GOA. Only three entanglements have been reported in the GOA longline fishery.

For killer whales, the combined mortality from the observed groundfish fisheries was 1.4 whales per year (Angliss *et al.* 2001). While it is most likely that whales interacting with fisheries are from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks.

For beaked whales (Baird's, Cuvier's, or Stejneger's), no incidental take or entanglement in BSAI and GOA groundfish trawl, longline, and pot fisheries has been documented (Hill and DeMaster 1999).

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries were identified as potential effect in the future since several of these species range outside of BSAI and GOA during the winter months. Subsistence take of some beluga whales would be expected to continue similar to the baseline conditions. Other species are not taken for subsistence purposes.

- **Cumulative Effects.** 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 FMP3.1 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 effects on the availability of prey for this groups 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 an the external factor having a potential effect on prey for these species in the future. Climate and regime shift are also identified but the direction and magnitude of these effect 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/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Spatial and temporal fishing measures under FMP 3.1 do not deviate from the baseline, which does 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 a 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.** Effects of disturbance from the groundfish fishery under FMP 3.1 on toothed whale populations are determined to be insignificant at the population level..

- **Persistent Past Effects.** Past potential disturbance effects on species in this group were identified for foreign, JV, and federal domestic groundfish fisheries, however, there is little indication of an adverse population-level effect. General vessel traffic likely also contributes to disturbance for 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 – FMP 3.2

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 FMP 3.1

Cumulative Effects

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 FMP 3.2 are the same as discussed under FMP 3.1.

4.7.8.8 Baleen Whales

Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With respect to incidental take and entanglement in marine debris incidental to groundfish fisheries, FMP 3.1 is expected to be similar to the baseline condition and to have insignificant effects on the population trajectories of other baleen whales. See the discussion provided for incidental take of other baleen whales in Section 4.5.8.8.

Fisheries Harvest of Prey Species

The effects of groundfish fisheries under FMP 3.1 are considered insignificant to baleen whales in regards to harvest of prey species due to the lack of competitive overlap in species targeted by each (see Section 4.5.8.8).

Spatial/Temporal Concentration of the Fishery

Groundfish fisheries have little, if any, competitive overlap with baleen whale forage species; therefore changes to the spatial/temporal concentration of the fisheries is expected to result in effects that are insignificant at the population level.

Disturbance

Disturbance of baleen whales under the FMP 3.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

Cumulative Effects

The past/present effects on the other baleen whale group are described in Sections 3.8.11 to 3.8.18 (Tables 3.8-11 through 3.8-18) and the predicted direct/indirect effects of the groundfish fishery under the FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-69. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effect.** The low level of take and entanglement of baleen whales projected to occur under FMP 3.1 is considered insignificant at the population level..

- **Persistent Past Effects.** Commercial whaling from last century has had a lingering effect on almost all of the baleen whales in this group with the possible exception of the minke whale. These include blue whales, fin whales, sei whales humpback whales, gray whales and right whales. A full discussion of the effects of commercial whaling is presented in Section 3.8.9. Subsistence harvest of whales 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 the International Whaling Commission which allows 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 (in October 1998 and February 1999) were reported by observers in the BS pollock trawl fishery operating near Unimak Pass. The extent of interactions between bowhead whales and the groundfish fishery is not known. Bowhead whales are present in the Bering Sea during winter and early spring but are usually associated with ice-covered regions. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Of 236 bowhead whales examined from the Alaskan subsistence harvest (from 1976 to 1992), three had visible ship-strike injuries from unknown sources and six had ropes attached or scars from fishing gear (primarily pot gear), one found dead was entangled in ropes similar to those used with fishing gear in the Bering Sea (Philo *et al.* 1992). Since 1992, additional bowhead whales have been observed entangled in pot gear or with scars from ropes. The extent of interactions between gray whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Since 1997, five entanglements (mostly in pot gear) and one ship strike mortality have been reported in Alaska waters. Since 1989, no incidental takes of right whales are known to have occurred in the north Pacific. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. Because the right whale population is believed to be very small, any mortality incidental to commercial fisheries would be considered to be significant. Yet, based on the lack of reported mortalities of right whales, the estimated annual mortality rate incidental to commercial fisheries is zero whales per year from this stock.

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries are expected to continue to take small numbers of baleen whales in the coming years. Entanglement in fishing gear will also continue to affect baleen whales throughout their ranges. Subsistence harvest for gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal effects of the fishery and contributions from external factors are considered conditionally significant adverse for fin, humpback, and northern right whales due to past effects on their population, potential for interactions with fisheries, and their endangered status. Right whales are very rare so even one human-caused mortality could be considered significant. Given the overlap of their preferred habitat with the BSAI fisheries, the chances of future adverse interactions with fishing gear are more than negligible. The adverse rating for these three species is conditional on whether future take or entanglement substantially affects their rates of recovery. Cumulative effects are found to be insignificant for the endangered blue, bowhead, and sei whales. These species rarely interact with the fisheries so population-level effects are not anticipated. Mortality is also considered insignificant for non-ESA-listed minke and gray whales. Population-level effects are not expected for either of these species.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 3.1 are determined to be insignificant to baleen whale species in regards to harvest of prey species and the lack of competitive overlap in species targeted by each.

- **Persistent Past Effects.** Persistent past effects on availability of prey were not identified due to the lack of competitive overlap in prey species targeted.

- **Reasonably Foreseeable Future External Effects.** Future external effects were identified from state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species would not be expected to be affected through prey availability.

- **Cumulative Effects.** Cumulative effects of prey availability on baleen whale species are not anticipated on a population level for any of the species in this group primarily due to the limited overlap of prey species with fisheries. The effects are considered insignificant for all species.

Temporal and Spatial Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal concentration of fishery harvests under FMP 3.1 do not deviate substantially from the baseline; thus the effects are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects of temporal and spatial concentrations of the fisheries were not identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries would be expected to continue and would contribute to some degree of effect on some 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 those that occurred to other baleen whales under baseline conditions are expected under FMP 3.1 and are considered insignificant.

- **Persistent Past Effects.** Some level of disturbance has likely occurred from foreign and JV fisheries, domestic groundfish fisheries, 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, whale watching, and commercial vessels would be expected to continue in future years in addition to 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 – FMP 3.2

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 FMP 3.1

Cumulative Effects

For species within the baleen whales group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP 3.2 are the same as discussed under FMP 3.1.

4.7.8.9 Sea Otters

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

Sea otter interactions with fishing gear, either passive or active, are infrequent. Laist (1997) reported that sea otter entanglement in marine debris is rare. Likewise, incidental takes in fishing gear occur at a rate too low to cause population level effects. While the PBRs for the three sea otter stocks in Alaska were 871 (southeast), 2,095 (southcentral), and 5,699 (southwest), mortalities incidental to commercial fishing were 0, fewer than 1, and fewer than 2 per year, respectively (Angliss and Lodge 2002).

In southwest Alaska, the North Pacific Groundfish Observer Program reported eight kills in the Aleutian Islands sablefish 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 mortality and serious injury for the Alaska sea otter are considered to be insignificant (i.e., will not affect population trajectories). The level of incidental catch and entanglement for sea otters under FMP 3.1 is likely to be similar to the baseline condition and the effects are considered insignificant at the population level.

Fisheries Harvest of Prey Species

The effects of FMP 3.1 on sea otters are limited by differences between their prey and the fisheries harvest targets. Sea otters consume a wide variety of prey species, including annelid worms, crabs, shrimp, mollusks (e.g., chitons, limpets, snails, clams, mussels, and octopus), sea urchins, and tunicates. Occasionally, groundfish (e.g., sablefish, rock greenling, and Atka mackerel) may also be consumed but invertebrates are considered the predominant elements of their diet (Kenyon 1969, USFWS 1994). Given the minor importance of groundfish in their diet, fisheries removals under FMP 3.1 are expected to be similar to the baseline condition and the effects on prey availability to otters are considered insignificant at the population level.

Spatial/Temporal Concentration of the Fishery

The grounds for suggesting competition for forage between sea otters and commercial fisheries are 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 1 km of the shore (Kenyon 1969). In areas where shallow waters extend far offshore (e.g., Unimak Island), sea otters have been reported as far as 16 km offshore. They are often seen resting and diving for food in and near kelp beds (Kenyon 1969). Because of this habitat preference for shallow areas, they do not overlap spatially with groundfish fisheries. Since the spatial and temporal concentration of the fisheries under FMP 3.1 is expected to be similar to the baseline, which does not appear to affect the localized abundance of sea otter prey, FMP 3.1 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 passing by (Richardson *et al.* 1995). Sea otters may be more tolerant of underwater sound relative to other species, owing to the greater amount of time they spend at the surface. Levels of disturbance under FMP 3.1 are expected to be similar to the baseline level and are therefore considered insignificant for sea otters.

Cumulative Effects

The past/present effects on the sea otter are described in Section 3.8.10 (Table 3.8-10). Representative direct effects used in this analysis include mortality and disturbance. Major indirect effects are availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The effects of incidental take and entanglement on sea otters under FMP 3.1 are considered insignificant.

- **Persistent Past Effects.** Commercial exploitation for pelts had a huge impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Protective measures instituted in 1911 have allowed remnant groups to increase and reoccupy much of the historic sea otter range in Alaska (Kenyon 1969, Estes 1980). Residual effects from this early harvest likely persist in several areas. Alaska Natives have hunted sea otters for pelts and meat throughout history. Current harvest levels represent 9 percent of PBR for the southwestern stock, 15 percent of PBR for the southcentral stock, and 35 percent of PBR for southeast stock. (USFWS 2002a, 2002b and 2002c). In 1992, fisheries observers reported 8 sea otters taken incidentally by the Aleutian Island Black Cod Pot Fishery. During that year, only a third of the fisheries were observed, yielding an estimate of 24 otters killed in cod pot gear. No other sea otter takes were reported from observed fisheries in the range of the southwest stock from 1993 through 2000. In 1997, one sea otter was reported to have been taken 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 sea otter populations of southeast and southcentral Alaska appear to be stable or increasing and are not expected to have additional mortality pressures in the future. Cumulative effects for these stocks are therefore considered insignificant. The rapid decline of the southwest Alaska stock does not appear to be the result of food shortages, disease, or toxic contamination and is likely the result of increased predation by transient killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al.* 1998). Since the mechanisms of the population decline are still under investigation, the cumulative effects on the southwest stock are considered to be conditionally significant adverse from mortality.

Prey Availability

- **Direct/Indirect Effects.** The effects of the FMP 3.1 on sea otters are limited by differences between their prey and the fisheries harvest targets. As such, the effects of harvesting key prey species in groundfish fisheries are determined to be insignificant for sea otters.

- **Persistent Past Effects.** The groundfish fisheries have had little effect on the availability of prey in the past for sea otters due to the limited overlap in their prey species and the fish targeted by the groundfish fisheries. There is some minor overlap between state-managed crab fisheries and sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters were identified as having future external effects on sea otters. 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. Population-level effects are not anticipated.

Spatial/Temporal Concentration of the Fisheries

- **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/temporal concentrations 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 FMP 3.1 are expected to be similar to the baseline; therefore, the effects of disturbance on sea otters are considered 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 similar level to the baseline conditions. Vessel traffic within sea otter habitat in future years would also be expected to be similar to the baseline.

- **Cumulative Effects.** Cumulative effects of disturbance on sea otters are considered insignificant and are unlikely to result in any population-level effects. Contribution of the groundfish fishery to the overall cumulative effect is minor.

Direct/Indirect Effects – FMP 3.2

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 FMP 3.1

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 FMP 3.2 are the same as discussed under FMP 3.1.

4.7.9 Socioeconomic Alternative 3 Analysis

This alternative would seek to accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles and, where appropriate and practicable, increase habitat protection and impose additional bycatch constraints. This section contains both quantitative and qualitative assessments of select economic and social effects of FMP 3.1 and FMP 3.2.

In general, the quantitative economic outcomes of this management policy appear nearly identical to those projected under Alternative 1. No significant differences between the 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 such as product prices, harvesting and processing capacity and average costs that have not been quantified in the analysis.

4.7.9.1 Harvesting and Processing Sectors

The model and analytical framework used in the analysis of the effects of FMP 3.1 on the harvesting and processing sectors are described in Section 4.1.7.

Table 4.7-6 summarizes projected impacts of FMP 3.1 on harvesting and processing sectors. The numbers in the table reflect the 5-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 thousand mt to 297 thousand mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment and groundfish payments to labor.

4.7.9.1.1 Catcher Vessels

Direct/Indirect Effects of FMP 3.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period in Table 4.7-6 to 2001 catcher vessel conditions reveals that under FMP 3.1 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 55 percent. In addition, an increase in the TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant increase in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. This leads to direct/indirect effects ratings of insignificant and significantly beneficial (A-R-S-O) under FMP 3.1.

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, leading to a direct/indirect effect rating of insignificant under FMP 3.1. 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. These increases in catch are expected to occur despite the reduction in PSC limits for halibut, herring, crab, and salmon in the GOA and BSAI. Catcher vessel fisheries which currently close seasonally because they reach seasonal PSC limits include the Pacific cod fisheries in the GOA and BSAI, and the GOA flatfish fisheries.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase under FMP 3.1, 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, which leads to a direct/indirect effect rating of conditionally significant beneficial under FMP 3.1. The significance of the decrease is conditional because it is uncertain to what extent FMP 3.1 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, which leads to a direct/indirect effect rating of conditionally significant beneficial under FMP 3.1. The significance of the decrease in average costs is conditional because it is uncertain to what extent FMP 3.1 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.

The measures under FMP 3.1 include potential increases in time and area closures to protect the Steller sea lion. These time and area closures could result in increased operating costs and/or reduced harvest levels, and higher costs could offset some of the savings made through rationalization. In addition, a proposal to implement major changes in the time and area provisions of the existing Steller sea lion protection measures might require additional consultation under Section 7 of the ESA. These consultations could result in measures that further restrict fishing operations. Alternatively, improving the data on the interaction of Steller sea lions and fisheries may allow for relaxation of some of Steller sea lion protection measures and result in beneficial economic benefits for fishery participants.

Fishing Vessel Safety

A conditionally significant increase in fishing vessel safety is expected under this FMP relative to the comparative baseline, which leads to a direct/indirect effect rating of conditionally significant beneficial under FMP 3.1. The significance of the increase in fishing vessel safety is conditional because it is uncertain to what extent FMP 3.1 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 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 or biological conditions (e.g., spawning aggregations) may still encourage fishermen to fish at times or in places that are unsafe.

Cumulative Effects of FMP 3.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety.

<u>Groundfish Landings By Species Group</u>

- **Direct/Indirect Effects.** An insignificant change in retained harvest of groundfish relative to the comparative baseline is projected under FMP 3.1 with the exception of Pacific cod, sablefish and rockfish which are likely to increase significantly. This leads to direct/indirect effects ratings of insignificant/significantly beneficial under FMP 3.1.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects.** Given the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under FMP 3.1. 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 FMP 3.1. 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 or diversity as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is not expected to increase significantly under FMP 3.1.

- **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 contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** 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 (11 percent) that are predicted for FMP 3.1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from FMP 3.1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Changes in ex-vessel value relative to the baseline under FMP 3.1 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 contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (10 percent) under FMP 3.1, may mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (11 percent) under FMP 3.1. Therefore, cumulative effects on employment and payments to labor are expected to be insignificantly beneficial under FMP 3.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Changes in excess capacity are likely to be conditionally significant beneficial under FMP 3.1.

- **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 contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Under FMP 3.1, the extent to which rights-based management would be implemented in groundfish fisheries is uncertain. Should rights-based management extend to many of the groundfish fisheries, excess capacity would be reduced in that particular fishery. Excess capacity currently exists in other 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 to additional groundfish fisheries, a conditionally significant beneficial cumulative effect is likely for excess capacity under this FMP. (For details see the Overcapacity Paper in Appendix F-8).

Average Costs

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects are expected to occur for average costs under FMP 3.1.

- **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 contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Area closures also affect average costs through increases or decreases in transit time to fishing areas. Increases in closure areas, increase costs whereas decreases in closures usually decrease costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with average costs in the groundfish fishery, cumulative effects may result. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. The extent to which rights-based management and community cooperatives would be implemented is uncertain. Should these programs be implemented average costs would be reduced. Overall, conditionally significant beneficial cumulative effects are projected for average costs under FMP 3.1.

<u>Fishing Vessel Safety</u>

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects are predicted under FMP 3.1.

- **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 contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Under FMP 3.1, vessel safety could improve due to the end of the race for fish and less pressure to fish under dangerous conditions. Closures implemented through 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 is projected for FMP 3.1 as a result of rights-based management that could be implemented.

Direct/Indirect Effects of FMP 3.2

Table 4.7-6 summarizes projected impacts of FMP 3.2 on harvesting and processing sectors. The numbers in the table reflect the 5-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 30 percent, from 218 thousand mt to 284 thousand mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment and groundfish payments to labor. Bycatch of non-target species and PSC is expected to decrease with incentives includes in rationalization programs.

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 catcher vessel conditions reveals that under FMP 3.2 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 48 percent, leading to a significantly beneficial effect under this FMP. 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, leading to a significantly adverse effect under this FMP. Retained harvests of pollock and flatfish are not expected to change significantly.

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 FMP 3.2 such as bycatch reduction incentive programs and 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 FMP 3.2, 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 FMP 3.2 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 rating for the direct/indirect effect under FMP 3.2. 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 community quota 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

Either a significant increase or decrease in average costs could occur under FMP 3.2 relative to the comparative baseline, leading to direct/indirect effects ratings of significantly adverse and significantly beneficial. Increased spatial/temporal closures as well as restrictions on bottom trawling for pollock are likely to increase average costs, whereas the comprehensive rationalization program is likely to reduce costs. It is uncertain if the cost decreases would compensate for the cost increases.

The increase in buffer zones around Steller sea lion rookeries and haulouts under FMP 3.2 would likely result in vessels spending more time fishing farther from port, thereby increasing operating costs. In addition, a proposal to implement major changes in the time and area provisions of the existing Steller sea lion protection measures might require additional consultation under Section 7 of the ESA. These consultations could result in measures that further restrict fishing operations. Alternatively, improving the data on the interaction of Steller sea lions and fisheries may allow for relaxation of some of Steller sea lion protection measures and result in beneficial economic benefits for fishery participants.

Under FMP 3.2, spatial displacement of fishing effort due to the extensive closure areas to protect habitat could also lead to increased operating costs for vessels. The spatial displacement of fishing effort would 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.

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

Either a significant improvement or reduction in fishing vessel safety could occur under FMP 3.2 relative to the comparative baseline, leading to direct/indirect effects ratings of significantly beneficial/significantly adverse under FMP 3.2. 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, increased spatial/temporal closures will limit the areas and seasons available to fish, 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 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 may still encourage fishermen to fish at times or in places that are unsafe.

On the other hand, the additional area closures to protect habitat that are implemented under FMP 3.2 may 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.

Cumulative Effects of FMP 3.2

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 4.7-6). 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.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Insignificant cumulative effects are predicted under FMP 3.2 for most species except for Pacific cod which is expected to increase significantly. Sablefish and rockfish are expected to decrease significantly, leading to a significantly adverse direct/indirect effects rating.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects.** Although there are currently reductions in the commercial salmon and crab fisheries, the predicted increases in retained harvest of Pacific cod (48 percent) may help mitigate that effect. Reductions in harvest of the A-R-S-O complex (42 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 also expected to be mitigated by the increase in retained Pacific cod harvests. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these effects are not expected to be significant. Overall, cumulative effects are projected to be insignificant under FMP 3.2.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is not expected to increase significantly under FMP 3.2. 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 that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** While marginal changes in ex-vessel value in other fisheries may occur in the future, these changes are not expected to result in significant cumulative effects on groundfish ex-vessel value. 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 FMP 3.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Changes in employment and payments to labor relative to the baseline under FMP 3.2 are insignificant.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** 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 FMP 3.2. Payments to labor in other fisheries are not expected to contribute to significant cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on payments to labor are insignificant.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Changes in excess capacity are likely to be significantly beneficial under FMP 3.2.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Under FMP 3.2, the comprehensive rationalization program and expansion of the IFQ program would significantly reduce excess capacity. Although excess capacity would still remain in other fisheries such as salmon and crab, the program implemented under FMP 3.2 would have such a strong effect that the benefits would far outweigh the effects of overcapacity in other fisheries. (For details see the Overcapacity Paper in Appendix F-8). Significantly beneficial cumulative effects on excess capacity are likely.

Average Costs

- **Direct/Indirect Effects.** Significantly beneficial and significantly adverse effects are expected to occur for average costs under FMP 3.2.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Average costs 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 in Section 4.7.9.1 above, area closures also affect average costs through increases or decreases in transit time to fishing areas. Additional closures included in FMP 3.2 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. Therefore, 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. Significantly adverse or beneficial cumulative effects could result under FMP 3.2.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Significantly adverse or significantly beneficial effects are predicted for fishing vessel safety under FMP 3.2.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Under FMP 3.2, vessel safety could improve due to the end of the race for fish and rationalization. However, additional closures implemented through FMP 3.2 plus any closures implemented through other fisheries may adversely affect vessel safety causing vessels to travel farther and in potentially dangerous weather conditions. Thus, significantly beneficial or adverse cumulative effects are possible under this FMP, depending on these variables.

4.7.9.1.2 Catcher Processors

Direct/Indirect Effects of FMP 3.1

Groundfish Landings By Species Group

Comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that under FMP 3.1 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. This leads to direct/indirect effects ratings of insignificant and significantly beneficial for groundfish landings by species groups under FMP 3.1.

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. This leads to a direct/indirect effect rating of insignificant for groundfish gross product value under FMP 3.1.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under FMP 3.1, 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 FMP 3.1 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, 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 also 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 FMP 3.1 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 FMP 3.1 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 FMP 3.1 extends rights-based management to additional groundfish fisheries.

Cumulative Effects of FMP 3.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, insignificant effects are expected for retained harvests of groundfish species, except for Pacific cod, which is expected to result in significant increases (30 percent).

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue, 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 vessels that rely on a mix of groundfish, salmon and crab may experience a reduction in harvest levels. However, this cumulative effect will likely not result in significant changes in groundfish landings under FMP 3.1. 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 FMP 3.1. 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 or diversity as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is not expected to have significant changes from the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (8 percent) that are predicted for FMP 3.1 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 FMP 3.1.

<u>Employment and Payments to Labor</u>

- **Direct/Indirect Effects.** Insignificant changes in employment and payments to labor are predicted for catcher processors under FMP 3.1.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** 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 (8 percent) under FMP 3.1 is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (8 percent) under FMP 3.1 thereby mitigating some of the reductions in other fisheries. 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 FMP 3.1.

<u>Product Quality and Product Utilization Rate</u>

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects in product quality and product utilization rates are expected under FMP 3.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed under the Section 4.5.9.1.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, 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 FMP 3.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects in excess capacity are expected under FMP 3.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 3.1, conditionally significant cumulative effects are expected for excess capacity.

Average Costs

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects in average costs are expected under FMP 3.1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Area closures also affect average costs through increases or decreases in transit time to fishing areas. Increases in closure areas increase costs, whereas decreases in closures usually decrease costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with average costs in the groundfish fishery, cumulative effects may result. Should costs in other fisheries increase or decrease, catcher processors that are dependent on multiple fisheries are often sensitive to these changes. Assuming rights-based management extends to other groundfish fisheries under FMP 3.1, average costs would be reduced. As FMP 3.1 closures do not increase significantly from the baseline condition, cumulative effects on average costs in the groundfish fisheries are expected to be conditionally significant beneficial.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects for fishing vessel safety are expected under FMP 3.1.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen, however, these effects are not expected to be significant under FMP 3.1. The extent to which rights-based management is implemented under FMP 3.1 will affect vessel safety. As there are no predicted increases in area closures under FMP 3.1, 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 FMP 3.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that under FMP 3.2 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 24 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. This leads to a range of effects ratings of insignificant to significantly beneficial to significantly adverse for groundfish landings by species groups under FMP 3.2.

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 FMP 3.1, but not significantly.

Product Quality and Product Utilization Rate

Either a significant improvement or reduction in product quality and utilization rates could occur under FMP 3.2 relative to the comparative baseline, leading to direct/indirect effects ratings of significantly beneficial and significantly adverse. 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 FMP 3.2 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 FMP 3.2 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 outnumber the vessels that are AFA-eligible, the reduction in excess capacity resulting from rationalization should be significant.

Average Costs

The net effect of the FMP is unknown with regard to average costs. As with catcher vessels, the various measures under FMP 3.2 are likely to both significantly increase and decrease costs relative to the comparative baseline, leading to significantly beneficial and significantly adverse direct/indirect effects ratings. Increased spatial/temporal closures as well as restrictions on bottom trawling for pollock are likely to increase average costs, whereas the comprehensive rationalization program is likely to reduce costs. Unlike catcher vessels, catcher processors are not linked to inshore processing facilities and therefore are more likely to be able to adapt to area closures.

Fishing Vessel Safety

As with catcher vessels, either a significant improvement or reduction in fishing vessel safety could occur under FMP 3.2 relative to the comparative baseline, leading to significantly beneficial and significantly adverse direct/indirect effects ratings. 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, increased spatial/temporal closures will limit the areas and seasons available to fish, and are likely to force vessels to operate farther from shore and in less than optimal weather conditions.

Cumulative Effects of FMP 3.2

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 4.7-6). 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.** Overall, insignificant changes in groundfish harvests are expected under FMP 3.2, however increases in Pacific cod and decreases in rockfish and sablefish are predicted for this FMP.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** As stated under FMP 3.1, 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 FMP 3.2. An increase in TAC for Pacific cod in the BSAI and GOA is expected (24 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 FMP 3.2. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these effects are not expected to result in significant changes under this FMP. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to 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 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described under FMP 3.1, insignificant cumulative effects on ex-vessel value are expected to result from FMP 3.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Insignificant changes in employment and payments to labor are predicted for catcher processors under FMP 3.2.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Total employment and payments to labor are expected to increase under FMP 3.2. 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 (7 percent) under FMP 3.2, may mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (7 percent) under FMP 3.2. 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 FMP 3.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** A significantly beneficial or adverse effect on product quality and product utilization rates are possible under FMP 3.2, however it is difficult to predict.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed under Section 4.5.9.1.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, the additional closures under this FMP may make it more difficult to preserve the quality achieved through better handling. The increase in rights-based management implemented under FMP 3.2 will provide incentives for catcher processors to get the maximum value per unit of fish but they may have to travel farther to catch them. Overall, significantly beneficial or adverse cumulative effects are possible for product quality and utilization under FMP 3.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** A significantly beneficial effect in excess capacity is expected under FMP 3.2 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 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** As with FMP 3.1, 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 (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as well as being expanded in the groundfish fisheries under FMP 3.2, significantly beneficial cumulative effects are expected for excess capacity.

Average Costs

- **Direct/Indirect Effects.** Various measures under FMP 3.2 are likely to both increase and decrease average costs. The net effect of FMP 3.2 on average costs is unknown. More details on these effects are located in the direct/indirect section above.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described in more detail under FMP 3.1, average costs in the groundfish fisheries are often associated or shared with other fisheries and include both fixed costs and variable costs. Area closures also affect average costs through increases or decreases in transit time to fishing areas. Since catcher processors are more adaptable to area closures because they are not tied to inshore processors, the effects of these on average costs are not significant. The effects of comprehensive rationalization under this FMP are likely to reduce costs, although this assumes that fish taxes do not indirectly increase average costs. Significantly beneficial or adverse cumulative effects are possible under FMP 3.2.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Significantly beneficial and adverse effects for fishing vessel safety are possible under FMP 3.2. The net effect of this FMP on vessel safety is uncertain. Details on the direct/indirect effects are located at the beginning of this section.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen. Although the end to the race for fish will have significant benefits for vessel safety under this FMP, the increase in closures may diminish this effect. Therefore, significantly beneficial or adverse cumulative effects are possible under FMP 3.2.

4.7.9.1.3 Inshore Processors and Motherships

Direct/Indirect Effects of FMP 3.1

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 FMP 3.1 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. This leads to direct/indirect effects ratings of insignificant and significantly beneficial for groundfish landings by species group under FMP 3.1.

Groundfish Gross Product Value

The wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to Bering Sea pollock shore plants, Alaska Peninsula and Aleutian Islands shore plants, Kodiak shore plants, and floating inshore processors account for much of the increase in groundfish product value. Southeast Alaska shore plants and southcentral Alaska shore plants are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under FMP 3.1, 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 FMP 3.1 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 FMP 3.1 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, managed under the American Fisheries Act, 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 FMP 3.1 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.

Cumulative Effects of FMP 3.1

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 4.7-6). 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.** Overall, retained harvests of groundfish species are expected to be insignificant, except for Pacific cod. With a projected 50% increase in Pacific cod, landings are expected to have significant effects.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue, and are described in detail in Section 4.5.9.1.

- **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 also 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 for groundfish (except for significant increases in Pacific cod), insignificant cumulative effects may result under FMP 3.1. 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 or diversity as explained in more detail in Section 4.5.10, these changes are not expected to result in insignificant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase from the baseline, but not significantly.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (10 percent) that are predicted for FMP 3.1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from FMP 3.1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Employment and payments to labor are expected to increase under FMP 3.1, but not significantly.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Processors that rely on salmon and crab may continue to experience reductions in employment and payments to labor. Groundfish projections under FMP 3.1 are not significant (10 percent) but may mitigate some of the reductions due to salmon and crab. Processors may also experience increases if they process halibut and groundfish due to recent increases in the halibut fishery. Under FMP 3.1, the combination of reductions and increases in these multiple fisheries are likely to result in insignificant cumulative effects on employment and payments to labor.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** A conditionally significant increase in product quality and utilization rate is expected under FMP 3.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **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 also 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 FMP 3.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** A conditionally significant beneficial effect in excess capacity is expected under FMP 3.1 relative to the baseline. Capacity is expected to decrease.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Should rights-based management extend to additional groundfish fisheries, excess capacity would be further reduced. However, rights-based management is optional under FMP 3.1, 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 FMP 3.1 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 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described under 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. Should costs or closure areas in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. As FMP 3.1 closures change significantly from the baseline condition, rights-based management may occur, and a conditionally significant beneficial cumulative effect on average costs in the groundfish fisheries is expected.

Direct/Indirect Effects of FMP 3.2

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 FMP 3.2 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 43 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. This leads to direct/indirect effects ratings of insignificant, significantly adverse, and significantly beneficial for groundfish landings by species group under FMP 3.2.

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 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. Decreased deliveries of rockfish and sablefish will have a significantly adverse impact on the product value of southeast Alaska shore plants and southcentral Alaska shore plants. The product value of Alaska Peninsula and Aleutian Islands shore plants and Kodiak shore plants will also 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 FMP 3.2, but not significantly.

Product Quality and Product Utilization Rate

As with catcher processors, either a significant improvement or reduction in product quality and utilization rates could occur under FMP 3.2 relative to the comparative baseline, leading to direct/indirect effects ratings of significantly beneficial and significantly adverse. 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 that are implemented under FMP 3.2 may cause product quality to decrease. Pacific cod and Alaska pollock are fragile fish whose quality deteriorates rapidly longer times 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 FMP 3.2 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 FMP 3.2 is expected to result in a significant decrease in excess capacity in the processing sectors relative to the comparative baseline in the long-term, leading to a significantly beneficial direct/indirect effect rating. In the short run, 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

As with catcher vessels and catcher processors, the net effect of FMP 3.2 on average costs relative to the baseline is uncertain. The spatial/temporal closures 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 direct/indirect effects ratings of significantly beneficial and significantly adverse.

This FMP includes measures that result in considerable spatial/temporal displacement of fishing effort. The result could be reduced harvest levels and increases in average costs. On the other hand, 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.

Cumulative Effects of FMP 3.2

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 4.7-6). 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 FMP 3.2, however, sablefish and rockfish are projected to have a significant decrease. Pollock and flatfish harvests are not expected to change significantly.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, 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 also on groundfish and halibut catch may experience some increases in landings under FMP 3.2. 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 FMP 3.2. 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 or diversity as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase from the baseline but not significantly. Decreased deliveries of rockfish and sablefish will have a significantly adverse impact on the product value of southeast Alaska shore plants and southcentral Alaska shore plants. The product value of, Alaska Peninsula and Aleutian Islands shore plants and Kodiak shore plants will also be adversely affected by this decrease, but less so.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **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 contributions to education programs have been decreasing. Marginal increases in gross product value (5 percent) that are predicted for FMP 3.2 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from FMP 3.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Insignificant effects are predicted for catcher processors under FMP 3.2.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** 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 (7 percent) under FMP 3.2, is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (7 percent) under FMP 3.2 thereby mitigating some of the reductions in other fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under FMP 3.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** Either a significant improvement or reduction in product quality and utilization rates could occur under FMP 3.2 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Technological advances have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, the 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, significantly beneficial or adverse cumulative effects are possible under FMP 3.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly beneficial changes in excess capacity are possible under FMP 3.2 relative to the baseline over the long-term. The net effect of these measures on capacity are unknown. Details on these effects are presented at the beginning of this section under direct/indirect effects.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **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 (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 3.2, the cumulative effects on excess capacity are likely to be significantly beneficial compared the baseline.

Average Costs

- **Direct/Indirect Effects.** Both significantly beneficial and adverse effects are possible under this FMP. Spatial temporal closures 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 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described 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 FMP 3.2 is uncertain because increased spatial/temporal closures will increase costs, however the comprehensive rationalization of the fishery will greatly reduce costs. Details on these effects are located in the direct/ indirect discussion of inshore plants and motherships above. Significantly beneficial or adverse cumulative effects are possible under FMP 3.2.

4.7.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. 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 3.9-13) include the Aleutian Islands/Alaska Peninsula (comprised of the Aleutians East Borough and the Aleutians West Census Area, which includes the communities of Unalaska, Nikolski, Atka, Adak and the Pribilof Islands), Kodiak Island (Kodiak Island Borough, which includes the City of Kodiak) southcentral Alaska (the Kenai Peninsula Borough, Matanuska-Susitna Borough, Municipality of Anchorage, and the Valdez-Cordova Census Area, which includes the PWS region), southeast Alaska (all of the southeastern part of the state, from Yakutat Borough to Dixon Entrance), Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca), and Oregon coast (Lincoln, Tillamook, and Clatsop counties, the three northernmost Oregon coastal counties). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case.

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 FTEs.

As discussed earlier, these indicators also reflect changes in other important regional characteristics such as secondary economic activity associated with the support of fishing, state and municipal revenue generated by fishing, and indirectly population, to the extent that it is related to employment opportunities. For more information on the economic model used to assess direct and indirect regional effects, see the analysis for FMP 1 and Section 4.1.7 of this document.

Direct/Indirect Effects of FMP 3.1

FMP 3.1 represents a more precautionary approach to fisheries management that extends management measures currently being employed or evaluated. This includes further rationalization of the groundfish fishery and additional measures related to bycatch, protection of prohibited species, and habitat protection. Under FMP 3.1, 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. None of these changes, however, 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). However, one of the major changes from previous alternatives is the intent to rationalize the groundfish fishery. The potential effects of rationalization, particularly indirect and induced effects, are not completely captured in the model. These include 1) potential consolidation of the harvesting and processing sectors, where total employment is reduced but lasts for longer periods with higher pay, 2) transition of fishing support sectors from a peak-demand/race for fish to a lower level of year-round demand, with similar employment effects, 3) consideration of additional closure areas to protect habitat, which may have disproportionate effects on smaller fixed gear vessels, and 4) the possibility of regional protection measures, such as landing or co-op requirements, that cannot be assessed at this time.

In general, the community level effects of rationalization, in and of itself, are anticipated to result primarily from a redistribution of participation, effort, and activity between and within regions rather than from changes at the overall fishery level. Potential adverse impacts to specific local communities resulting from rationalization programs are largely associated with the nature and magnitude of consolidation of harvesting and processing capacity or effort following the implementation of rationalization measures (although other impacts are associated with changes in temporal distribution of effort). These impacts could be profound in some communities, especially for those communities that are remote or marginal in their participation relative to the overall fishery or its established centers. It is likely that future rationalization programs would incorporate some type of regional or community protection measures to provide for the sustained participation of fishing communities, such as those currently being contemplated in the ongoing analysis and evaluation of potential rationalization approaches for the Bering Sea and Aleutian Islands crab fisheries. To a large extent, impacts to communities would be determined by the efficacy of the community protection measures, if any, included in any particular rationalization program. The discussion of these types of impacts in this section is largely qualitative rather than quantitative as particular rationalization approaches and accompanying regional or community protection measures will depend on program specifics that have not been developed. The potential effects of rationalization on communities are further described in the overcapacity qualitative analysis in Appendix F of this PSEIS.

The following subsections provide a region-by-region summary of change under FMP 3.1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 3.1, total in-region groundfish processing value would increase (with increases occurring in 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 and FTEs would also 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 FMP (from a base of $226 million in labor income and 4,796 FTEs), but this increase would not be significant. Under FMP 3.1, the more closely defined sector 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 FMP may result in a number of other types of impacts that could be significant under certain conditions.

Under this FMP, 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. All things being equal, the number of processing and harvesting entities will decline, as will overall employment. If consolidation results in the loss of some local groundfish processing markets, small vessels in those local markets would be disproportionately vulnerable to adverse impacts, as they are inherently less able to be flexible in their activities over wide geographic areas than are larger vessels. (Small vessel owners would presumably be assured of equity in the initial allocation of harvest quota itself, and of the ability to sustain their participation in the fishery, as MSA Section 303(d)(5)c) mandates that any new IFQ program must consider the allocation of a portion of the annual harvest in the fishery for small vessel owners.) 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). 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 but are available in a more timely manner than other potential options are often deemed well worth the trade-off. Under a rationalized fishery, cost considerations become relatively more important, giving service purchasers more options (to the possible detriment of providers in comparatively remote locations). These types of impacts will be seen in other regions as well (especially Kodiak), but will perhaps be most apparent or severe in this region due to a relative lack of diversification in the local economies of the relevant fishing communities. 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 specific yet-to-be-designed protection measures.

Kodiak Island. Total in-region groundfish processing value would increase (with higher values for GOA; BSAI values are not a significant portion of the regional total) as would associated labor income and FTE jobs, 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 BSAI values), as would associated labor income and FTEs, but these changes would not 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 seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would increase, as would FTE employment under this FMP (from a base of $66 million in labor income and

1,600 FTEs), but none of these changes would be considered significant. For the Kodiak Island region, FMP 3.1 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, however, there could be some adverse impacts to Kodiak Island region support services based on 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 attributable to GOA increases). Associated labor income and FTE jobs would also increase by 36 percent. Regionally owned at-sea processing value would increase by 28 percent (with relatively large increases in BSAI values and smaller increases in GOA values), and associated labor income and FTEs both increasing 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 42 percent. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase by about 42 and 41 percent, respectively. Similarly, for in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 42 and 41 percent, respectively. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 28 percent and FTE employment would increase by a slightly less than significant amount (from a base of $23 million in labor income and 567 FTEs). For the southcentral Alaska region, FMP 3.1 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 attributable to GOA decreases), as would associated labor income and FTE jobs (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 both would 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 by about 20 percent. For 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, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease as would FTE employment (from a base of $34 million in labor income and 879 FTEs), but these changes would be less than significant. The impacts from FMP 3.1 are likely to be significantly 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 changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase (with increases in both BSAI and GOA values, although GOA values are comparatively very small), and 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 (from a base of $557 million in labor income and 10,316 FTEs), but these changes would not be significant. FMP 3.1 would have consistently beneficial benefits 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 FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but 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 FMP. The total regional direct, indirect, and induced labor income would increase, as would FTE employment (from a base of $15 million in labor income and 318 FTEs), but these changes would not be significant. FMP 3.1 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 FMP 3.1

See Table 4.7-6 for a summary of the cumulative effects on regional socioeconomics under FMPs 3.1 and FMP 3.2.

<u>In-Region Processing and Related Effects</u>

- **Direct/Indirect Effects.** For FMP 3.1, direct/indirect effects are considered insignificant for all regions except the southcentral Alaska region, which is significantly beneficial due to projected increase in labor income and FTE employment.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1, 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, where external effects likely result in conditionally significant adverse cumulative effects. 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. Rationalization will likely result in the need to coordinate delivery and processing schedules in processors participating in multi-species fisheries, but the effects can not be determined.

<u>Regionally Owned At-Sea Processors</u>

- **Direct/Indirect Effects.** Under FMP 3.1, direct/indirect effects are considered significantly beneficial for the southcentral and southeast Alaska regions. Direct/indirect effects are generally insignificant for the remaining 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. For more detail, see the analysis for In-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1, cumulative effects on regionally owned at-sea processing and on related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. While direct/indirect effects are beneficial for southcentral and southeast Alaska regions, reasonably foreseeable external effects will not contribute much to cumulative effects, particularly given the size and diversity of the regional economies. Direct/indirect effects are insignificant in the Alaska Peninsula/Aleutian Islands and Kodiak Island, where most of the

Alaska at sea processor fleet is based. As indicated previously, with a more diversified economy and population base, cumulative effects in Kodiak will be adverse due to external factors, but cumulatively insignificant, as are effects for the Alaska Peninsula/Aleutian Islands.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 3.1, 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. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1, extra-regional deliveries increase and direct/indirect effects are insignificant for the 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.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 3.1, 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 FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1, the direct/indirect effects range from beneficial to mostly insignificant. Given the size and diversity of regional economies in Washington inland waters, the Oregon coast regions, Alaska Peninsula/Aleutian Islands, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. Significantly beneficial cumulative effects are expected for southcentral Alaska.

Total Direct, Indirect, and Induced Labor Income and FTE's

- **Direct/Indirect Effects.** Under FMP 3.1, 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 FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1 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 and southeast Alaska regions, where effects are conditionally significant adverse.

Direct/Indirect Effects of FMP 3.2

Under FMP 3.2, in general the pattern of gains and losses in socioeconomic indicator values across regions is more mixed than seen in the previous FMPs. 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 (again, 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, but also has an adverse impact on the Kodiak region. The western GOA area also 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 FMP 3.2, whereas the Kodiak, southcentral, and southeast Alaska regions experience a net adverse impact in socioeconomic terms.

Regional and community impacts associated with the rationalization component of FMP 3.2, in and of itself, would be similar to those described under FMP 3.1. Under this FMP, however, there are many additional local area closures and it is to be expected (but is not apparent in the data) the smaller catcher vessels with less effective range (and therefore less inherent geographic flexibility) would feel disproportionate impacts in all regions. The rationalization that occurs under this FMP 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, of course, conditional on being able to find fish outside of the closed areas. These pragmatic challenges may "tip" adverse impacts from borderline to significant for some communities, depending the composition of the local fleet, particularly in the southcentral and southeast regions. The following subsections provide a region-by-region summary of change under FMP 3.2 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 3.2, 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), as would in region processing associated labor income and FTE jobs, but these increases would be less than 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 deliveries by regionally owned catcher vessels would decrease by a less than significant amount, while in-region deliveries by regionally owned catcher vessels would decrease by 22 percent. Catcher vessel payments to labor would decrease (but not significantly) 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 (from a base of $226 million in labor income and 4,796 FTEs), but these changes would be less than significant. In terms of quantitative output, the impacts of FMP 3.2 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 likely to illustrate significant impacts on the regional level (and community level quantitative data is largely unavailable due to confidentiality restrictions). There are, however, two other types of regional or community impacts likely under this FMP that are not apparent in the quantitative data.

In general, as noted under FMP 3.1, 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 the local economies of the relevant fishing communities. 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 specific yet-to-be-designed protection measures.

Another type of impact that is not captured by the economic output model is also likely to be important for some communities in the Alaska Peninsula and Aleutian Islands region. Under FMP 3.2, 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. Clearly, however, the small vessel fleets within this region are particularly vulnerable, and it is important to recognize that the fleets of some regional communities already face adverse circumstances under existing conditions resulting from the cumulative effects of Steller sea lion protection measure closures, a precipitous decline in economic returns from the salmon fishery, and Area M salmon intercept avoidance based restrictions, among others. Further, communities within this region that have both (1) support service sectors that may experience decline as a result of rationalization and (2) small vessel fleets may experience a range of interactive impacts that are not apparent from quantitative modeling outputs.

Kodiak Island. Total in-region groundfish processing value would decrease (with higher values for GOA; BSAI values are not a significant portion of the regional total), as would associated labor income and FTE jobs, 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 BSAI values), and associated labor income and FTEs also 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 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 associated with extra-regional deliveries, but none of these changes would all be less than significant, and FTE jobs would remain about the same. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by a less than significant 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 (from a base of $66 million in labor income and 1,600 FTEs), but all of these changes would be less than significant. For the Kodiak Island region, FMP 3.2 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, however, there may be conditionally significant impacts accrue to (1) the support service sector as a result of the rationalization features of this FMP and (2) 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 (all attributable to GOA decreases), as would associated labor income and FTE jobs, but these decreases would not be considered significant. Regionally owned at-sea processing value would decrease (with decreases in BSAI values and GOA values), as would associated labor income and FTEs, 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 21 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, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease as would FTE employment (from a base of $23 million in labor income and 567 FTEs), but none of these changes would appear significant. For southcentral Alaska, FMP 3.2 would not result in significant impacts at a local sector or at 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 (all 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), along with associated labor income and FTEs, 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 34 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 34 and 33 percent, respectively. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease by about 33 percent and FTE employment would also decrease by about 21 percent (from a base of $34 million in labor income and 879 FTEs). For the southeast Alaska region, FMP 3.2 would have significant impacts on some local sectors, but a caveat on these 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 an 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 not significant. Regionally owned at-sea processing value would increase (with increases in both BSAI and GOA values, although GOA values are comparatively very small), as would associated labor income and FTEs, 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, as would FTE employment (from a base of $557 million in labor income and 10,316 FTEs), but these changes would be less than significant. In general, the impacts of FMP 3.2 would not be significant for the Washington inland waters region. Impacts to local sectors are likely to be less than significant, 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 FMP do not apply to the Washington inland waters region in the same way that they do to the Alaska regions, nor do concerns regarding unintended consequences of rationalization on support sector businesses. Washington inlands 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 FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but 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 FMP. The total regional direct, indirect, and induced labor income would increase as would FTE employment (from a base of $15 million in labor income and 318 FTEs), but these changes would be considered less than significant. Under FMP 3.2, Oregon coast local sectors would experience beneficial but less than significant impacts, and regional and community impacts would also 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 via changes in the support sector businesses that may accompany further rationalization of the fishery.

Cumulative Effects of FMP 3.2

See Table 4.7-6 for a summary of the cumulative effects on regional socioeconomics under FMPs 3.1 and FMP 3.2.

In-Region Processing and Related Effects

- **Direct/Indirect Effects.** For FMP 3.2, direct/indirect effects are considered insignificant for all regions except the southeast Alaska region, which is significantly adverse. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, in terms of direct/indirect impact, the Alaska Peninsula/Aleutian Islands, Washington inland waters, and Oregon coast regions experience a net beneficial impact under FMP 3.2, whereas the Kodiak Island, southcentral, and southeast Alaska regions experience a net adverse impact in socioeconomic terms. 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 will be insignificant; cumulative effects for Kodiak Island, southeast Alaska, and portions of Alaska Peninsula/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.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** For FMP 3.2, direct/indirect effects are insignificant for all regions. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, direct/indirect effects are insignificant for all six regions. Cumulative effects are also insignificant for FMP 3.2, for the same reasons discussed under FMP 3.1.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 3.2, direct and indirect effects are insignificant for all regions, except southeast Alaska where they are significantly adverse. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, cumulative effects are insignificant for all regions, except for southeast Alaska, where they are 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 southeast Alaska and the Alaska Peninsula/Aleutian Islands, adverse external effects are likely to result in conditionally significant adverse cumulative effects.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 3.2, 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. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, 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, significantly 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 FMP 3.2, direct/indirect effects on labor income and employment are insignificant for all regions except southeast Alaska, which is significantly adverse. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, 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.

4.7.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under FMPs 3.1 and FMP 3.2 are described below. The past/present effects on CDQ are described in Section 3.9 (and summarized in Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.7-6). The representative indicator used in this analysis is allocation of catch to CDQ groups. It should be noted that allocation reflects potential revenue to CDQ groups, and indirectly the potential funds that are available for approved economic development activities in CDQ communities.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Under FMP 3.1 and FMP 3.2, the CDQ program would continue to operate as it does under baseline conditions. Under FMP 3.1, no adverse changes to the CDQ program or region in comparison to baseline conditions are foreseen.

Cumulative Effects of FMP 3.1 and FMP 3.2

For a summary of the direct/indirect and cumulative ratings see Table 4.7-6.

CDQ Allocations

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 3.1 and FMP 3.2 on the CDQ program are 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 the CDQ in 1992,1995,1996, and 1998; establishment of multi-species CDQ programs, and persistent limitations on economic development and associated employment activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMPs 3.1 and FMP 3.2, 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.

4.7.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. The past/present effects on subsistence are described in Section 3.9 (and summarized in Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, sport and personal use, and long-term climate change and regime shift.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Potential impacts to subsistence fall into four main categories: subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon in western Alaska and bycatch in the groundfish fisheries, and indirect impacts on other subsistence activities, including loss of income that would be otherwise directed toward subsistence pursuits, and the loss of access to commercial fishing vessels and gear that would be otherwise be available for joint production opportunities. Under FMP 3.1 and FMP 3.2, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. There is also no indication that this FMP would have an adverse impact on Steller sea lion subsistence activities or take over baseline conditions. Salmon bycatch would likely be decreased under this FMP due to a moderate reduction in PSC limits, and bycatch reduction incentives with rationalization under FMP 3.2. However, 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 FMP, therefore there would be no indirect impacts to subsistence through a decline in income or joint production opportunities.

Cumulative Effects of FMP 3.1 and FMP 3.2

The predicted direct and indirect effects of the groundfish fishery under the FMP 3.1 and FMP 3.2 are described above. The past/present effects on subsistence are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. Representative indicators used in this analysis are the same as those used in the direct/indirect analysis and include subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon, and indirect impacts on other subsistence activities such as income and joint production opportunities.

<u>Subsistence Use of Groundfish</u>

- **Direct/Indirect Effects.** Under this FMP, no changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline subsistence groundfish fishing conditions.

- **Persistent Past Effects.** Foreign, JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries and long-term climate change have the potential to adversely contribute to subsistence use of the groundfish fisheries. Economic development and sport and personal use are not likely to adversely contribute to subsistence use of the groundfish fisheries. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, 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 subsistence use of groundfish are not likely to contribute to significantly adverse cumulative effects to the groundfish fisheries. However, other state-managed fisheries could have adverse impacts to the subsistence use of groundfish due to the direct competition for the same species, but these impacts 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 FMP 3.1 or FMP 3.2 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 the population of Steller sea lions due to a number of factors; a long-term decline in the relative importance of marine mammals in local diets; commercial groundfish fishing taking prey species utilized by Steller sea lions; and Steller sea lion protection measures designed to assist in population recovery instituted in 2000. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, economic development, and long-term climate change have the potential to adversely contribute to Steller sea lion subsistence activities. Sport and personal use is not likely to adversely contribute to subsistence use of Steller sea lions. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, 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, and sport and personal use of subsistence use of Steller sea lions are not likely to contribute adversely to the groundfish fisheries.

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 FMP 3.1 and significantly reduced under FMP 3.2. However, 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 FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts could all adversely contribute to salmon subsistence activities. Sport and personal use are not likely to adversely contribute to salmon subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, no adverse 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.

<u>Indirect Impacts on Other Subsistence Activities</u>

- **Direct/Indirect Effects.** Under this FMP, catcher vessel activity and labor income are anticipated to increase under FMP 3.1 or FMP 3.2 Therefore no adverse indirect impacts to subsistence are expected to occur through a decline in income or joint production opportunities.

- **Persistent Past Effects.** The past/present effects on the indirect impacts on other subsistence activities include joint production as a part of local groundfish and other commercial fishery development from the outset; and income from fishing used for investment in subsistence is similar to use of income from other activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts could all have indirect adverse or beneficial contributions to subsistence activities. Sport and personal uses not likely to adversely contribute to indirect impacts on other subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, 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 effected adversely. However, the external impacts of other fisheries, other economic development activities, and long-term climate change and regime shifts could potentially have indirect adverse contributions to subsistence use.

4.7.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 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 change and regime shifts (Table 4.7-6).

Direct/Indirect Effects of FMP 3.1

Potential impacts that drive Environmental Justice issues include employment/municipal revenue and taxes in communities with significant percentages of special populations (Alaska Native and minority processing workforce); revenue to Alaska Native-owned catcher vessels; revenue to Alaska Native-owned catcher processors; subsistence activities associated with groundfish, Steller sea lion, and salmon; 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 several 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 370 jobs; therefore, no Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $514 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated Environmental Justice impacts would occur. In this region, the ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this FMP, 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 unknown, 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 decrease over baseline conditions by about 25 jobs; therefore, no Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $85 million. Increased in-region processing value would correspond to additional 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 tend to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under this FMP, the total value of catcher vessel operations would increase as would corresponding labor income and employment. But given demographic assumptions, this is unlikely to be relevant as an Environmental Justice issue.

Southcentral Alaska. As described in existing conditions, Environmental Justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that Environmental Justice issues will be associated with any employment change. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to Environmental Justice concerns. Similarly, processing value increases, 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 FMP overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to Environmental Justice concerns. Processing value decreases but this change is not associated with Environmental Justice concerns.

Washington inland waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, Environmental Justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this FMP, at-sea processing labor income and FTEs both increase (if by less than significant amounts), so there are no Environmental Justice impacts associated with this change.

Oregon coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not linked to Environmental Justice concerns. See

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 FMP, 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, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. Subsistence activities where there are potential Environmental Justice issues include the following:

- Harvest of groundfish (which occurs to some extent in all four Alaska regions), Steller sea lion (primarily and activity in the Alaska Peninsula/Aleutian Islands region), and salmon (primarily an issue in western Alaska, where poor runs have adversely affected subsistence harvests).

- The loss of income from fishing that would otherwise be directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production (which occurs to some extent in all four Alaska regions).

While there are some concerns about the effect of the groundfish fishery on Steller sea lions and salmon bycatch, it has been determined that fishing under FMP 3.2 is not having significantly adverse contributions to Steller Sea lion and salmon populations and their availability for subsistence harvest. Income available for subsistence activities and joint income opportunities are likely to be similar to FMP 1, with slight increases over the baseline likely. Therefore, no associated Environmental Justice impacts are anticipated.

Cumulative Effects of FMP 3.1

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 are described above. The past/present effects on Environmental Justice issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicator used in this analysis is the same as that used in the direct/indirect analysis (Table 4.7-6).

- **Direct/Indirect Effects.** Under FMP 3.1, direct/indirect impacts range from beneficial (subsistence harvests) to adverse (reductions in catcher vessel activity in the Alaska Peninsula/Aleutian Islands, reduction in processing workforce in several regions), but they are not significant. Any changes in the commercial fishery that are anticipated would result in insignificant impacts to the Environmental Justice baseline.

- **Persistent Past Effects.** Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. Other sources of municipal 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 FMP 1.

- **Cumulative Effects.** Under FMP 3.1 an insignificant cumulative effect is identified for Environmental Justice. The direct/indirect effects on income for subsistence pursuits, and participation and employment opportunities for Alaska Natives in the fishery generally increase. Reductions in revenues to local communities in the Alaska Peninsula/Aleutian Islands, in conjunction with the external effects from the crab closures and downturn in the salmon industry could potentially effect Environmental Justice issues, but not of a magnitude to be significant. Effects from by-catch of salmon and Steller sea lion subsistence activities are beneficial, and 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 FMP 3.2

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 336 jobs; therefore, insignificant Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $510 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated Environmental Justice impacts would occur. In this region the ownership and crews of the catcher vessels are assumed to 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 FMP, 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 are considered conditionally significant adverse (resulting from MPA and rationalization design features) as impacts to Alaska Native communities with support service businesses may occur. These effects are conditional and depend 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 53 jobs, which may result in an Environmental Justice impact, but it is not significant. The total in-region groundfish processing value would decrease from $81 million to $74 million. Decreased in-region processing values would correspond to reduced municipal revenue and taxes to the City and the Kodiak Island Borough, but given local and regional demographics, this is not likely to be an Environmental Justice issue. Ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the City of Kodiak, and therefore the associated local fleet is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under this FMP, the total value of 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 thus it is unlikely that Environmental Justice issues will be associated with any employment change. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs 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 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 impacts in this region are insignificant. In general, combined direct, indirect, and 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 FMP, at-sea processing labor income and FTEs both increase but 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. Under this FMP, the direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are insignificant 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 FMP, 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, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. With regard to potential adverse impacts to subsistence activities, salmon-bycatch and habitat protection measures associated with this FMP are likely to benefit subsistence harvest of salmon and Steller sea lions, therefore no associated Environmental Justice impacts are anticipated. Fishery income available to support subsistence activities and opportunities for joint production in the Alaska Peninsula/Aleutian Islands region may decrease slightly under this FMP 3.2, but will not result in significantly adverse Environmental Justice issues.

Cumulative Effects of FMP 3.2

The predicted direct and indirect effects of the groundfish fishery under FMP 3.2 are described above. The past/present effects on Environmental Justice issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicator used in this analysis is the same as that used in the direct/indirect analysis (Table 4.7-6).

- **Direct/Indirect Effects.** Under FMP 3.2, direct/indirect impacts on Environmental Justice issues in the Alaska Peninsula and Aleutian Islands region are conditionally significant adverse, 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. For all other regions, however, insignificant Environmental Justice effects are expected.

- **Persistent Past Effects.** Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts have the potential to adversely or beneficially affect Environmental Justice issues. Other sources of municipal 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 FMP 1.

- **Cumulative Effects.** Under FMP 3.2, direct/indirect effects related to Environmental Justice are insignificant for all regions except for conditionally significant adverse effects in the Alaska Peninsula/Aleutian Islands due to reductions in catcher vessel activity. The external effects from the crab closures, downturn in the salmon industry, reductions in employment funded by public revenue, and reductions in revenue to Native communities are adverse. This is particularly true in the Alaska Peninsula/Aleutian Islands, where cumulative effects are conditionally significant adverse for Environmental Justice issues. While 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.

4.7.9.6 Market Channels and Benefits to U.S. Consumers

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. The past/present effects on market channels and benefits to U.S. consumers are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is benefits to U.S. consumers (Table 4.7-6).

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

FMP 3.1 and FMP 3.2 are not expected to have a significant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Under FMP 3.1 and FMP 3.2, 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 5-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing under FMP 3.1 and FMP 3.2. This wholesale product value mean is higher than the comparative baseline, but the increase is not significant.

The rationalization of groundfish fisheries occurring under FMP 3.2 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 FMP 3.1 and FMP 3.2

For a summary of the direct/indirect and cumulative ratings, see Table 4.7-6.

<u>Market Channels and Benefits to U.S. Consumers</u>

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, increases in benefits to U.S. consumers of groundfish products are expected to occur, but are insignificant.

- **Persistent Past Effects.** These effects on benefits to U.S. consumers of groundfish products include: Alaska Seafood Marketing Institute product promotion activities, research and public awareness regarding the health benefits of seafood consumption, aquaculture development increasing overall availability and demand for seafood products, and changes in processing technology increasing seafood quality.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable effects include other fisheries (supply of product) and long-term climate change and regime shift. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, 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 the U.S. consumers of groundfish products and the groundfish market channels. However, the wholesale groundfish product value in conjunction with products from other fisheries is not expected to change benefits to U.S. consumers. The long-term climate change and regime shift could adversely effect availability for market channels due to the natural fluctuations in groundfish stocks.

4.7.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (Including Non-Consumptive and Non-Use Benefits)

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. Benefits derived from marine ecosystems and associated species are used as a surrogate to evaluate non-consumptive and non-use benefits. The past/present effects on non-consumptive and non-use benefits to U.S. general public are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits) (Table 4.7-6).

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

FMP 3.1 is predicted to have no significant effects on the level of benefits the Bering Sea and GOA marine ecosystems and associated species provide relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 3.1 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 4.7.10 of the Programmatic SEIS.

As described in Section 3.9.7, the Bering Sea and GOA marine ecosystems and species associated with them provide a broad range of benefits to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value the public places on protecting ecological conditions, Section 3.9.7 provides a qualitative discussion of possible benefits provided by the Bering Sea and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people may not directly interact with the Bering Sea and GOA marine ecosystems and the various species associated with them but derive satisfaction from knowing that the structure and function of these ecosystems are protected.

The focus in this analysis is on the direct and indirect effects of the alternatives on ecosystem benefits other than those that accrue to members of society who make a living harvesting, processing and distributing BSAI and GOA groundfish products or who purchase and consume these products. The direct and indirect effects of the alternatives on firms and communities that derive value from the commercial harvest and processing of groundfish are described elsewhere in this SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of this SEIS.

The value people assign to those marine ecosystem benefits that are unrelated to commercial groundfish fisheries are thought to be considerable. For example, the value of protecting the Steller sea lion alone may be substantial. As discussed in Section 3.9.7, a contingent valuation study suggests that there is a significant willingness to pay on the part of the American public for an expanded federal Steller sea lion recovery program. At this time, however, there is insufficient information to provide a comprehensive measure of the benefits derived from these ecosystems and the various species associated with them.

FMP 3.1 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. These measures include a network of spatial/temporal closed areas that disperse fisheries geographically and seasonally, a prohibition on the use of non-pelagic trawl gear to fish for pollock in the BSAI, bycatch reduction measures such as the full retention requirement for Pacific cod and pollock, and measures to reduce the incidental catch of seabirds. Furthermore, as discussed in Section 4.7.10, FMP 3.1 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.

FMP 3.2 is predicted to significantly increase the level of benefits provided by the Bering Sea and GOA marine ecosystems and associated species, relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 3.2 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 4.7.10 of this SEIS.

FMP 3.2 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, FMP 3.2 closes off 20 percent of the EEZ as a "no-take" marine reserve (3 percent) or "no-bottom contact" marine protected area (17 percent) covering a full range of marine habitats within the 1,000-m bathymetric line (Figure 4.2-5). The closures aim to provide protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species.

Furthermore, FMP 3.2 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 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 may be an important part. Moreover, the experience with cooperatives in the BSAI pollock fishery shows that fishing may 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 4.7.10, the measures implemented under FMP 3.2 are expected to have significant 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 significant increase in the levels of some of the benefits these ecosystems and species provide.

Cumulative Effects of FMP 3.1 and FMP 3.2

For a summary of the direct/indirect and cumulative ratings, see Table 4.7-6.

<u>Benefits Derived from Marine Ecosystems and Associated Species</u>

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2 the risks of adverse effects that the Alaska groundfish fishery could have on marine ecosystems are reduced. FMP 3.1 is predicted to have a beneficial but insignificant impact on the levels of benefits these ecosystems and associated species generate; FMP 3.2 is predicted to have a beneficial significant impact.

- **Persistent Past Effects.** Persistent past effects on non-consumptive and non-use benefits include: an increase in public awareness of marine ecosystems; increased participation in recreational fishing and eco-tourism activities; and public perceptions with regard to fisheries management. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects include other fisheries, and long-term climate change and regime shifts. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, 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 significantly beneficial, respectively. Both alternatives result in some direct/indirect benefits. However, the external impacts of other fisheries, development activities and natural cycles contribute adversely to benefits the public derives from marine ecosystems and associated species. Fishery management measures under FMP 3.1 and FMP 3.2 could continue the introduction of non-native species and effect a change in pelagic forage availability. The spacial and temporal concentration of fishery impact on forage could reduce the following: spatial/temporal pressures of the groundfish fisheries on forage species, removal of top predators (potential for seabird bycatch and subsistence harvests of marine mammals), and risk of changes in species, functional, and structural habitat diversity for the ecosystem. The long-term climate change and regime shift could adversely effect ecosystems and associated species due to the natural fluctuations in groundfish stocks.

4.7.10 Ecosystem Alternative 3 Analysis

Ecosystems are populations (consisting of single species) and communities (consisting of two or more species) of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure (food web) and material cycles (movement of mass and energy among the groups). The following analyses of potential direct/indirect and cumulative effects of Alternative 3 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 analysis includes numerous indicators representing potential direct, indirect, and cumulative effects of Alternative 3, as well as specifics of FMB 3.1 and 3.2 where applicable. Significance thresholds for the effect categories are presented in Table 4.1-7.

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – Ecosystems

This section assesses the potential direct/indirect and cumulative effects of FMP 3.1 and FMP 3.2 on the BSAI and GOA ecosystems.

Change in Pelagic Forage Availability

Pelagic forage availability is assessed by evaluating population trends in pelagic forage biomass for species with age-structured population models. This includes walleye pollock in the GOA (Figure H.4-17 of Appendix H) and Bering Sea walleye pollock and Aleutian Islands Atka mackerel (Figure H.4-18 of Appendix H). Trends in bycatch of other forage species (herring, squid, and forage species group) in the groundfish fisheries are a measure of the potential impact on those groups in the BSAI and GOA (Figures H.4-19 and H.4-20 of Appendix H). Table 4.5-81 summarizes the average values from 2003-2008 for these measures and the percent change in the average values from the baseline amounts. Under FMP 3.1, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would decline by about 10 percent from the baseline and pelagic forage biomass (specifically, walleye pollock) in the GOA would increase by about 53 percent over the baseline. Twenty-year biomass projections show similar trends. Average biomass would still be within the bounds of estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species would increase by more than 85 percent in the BSAI and decline by about 25 percent in the GOA. The projected absolute quantity of bycatch in each region is relatively small (3,500 mt and 190 mt, respectively). Estimates of forage biomass from food web models of the EBS indicate that this bycatch is probably a small proportion of the total forage biomass (Aydin *et al.* 2002). However, lack of population-level assessments for some species in the forage species group means that corresponding species-level effects are unknown. On the basis of this analysis, FMP 3.1 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability.

In FMP 3.2, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would show a 10 percent average decline from the baseline and pelagic forage biomass (specifically, walleye pollock) in the GOA would increase about 55 percent over the baseline. Twenty-year biomass projections show similar trends. As in FMP 3.1, average biomass would be within the range of estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species would increase more than 50 percent in the BSAI and decline by about 43 percent in the GOA. However, the extensive fishing closure areas put forth under this FMP may change bycatch estimates in many ways but cannot be accurately predicted. The projected absolute quantity of bycatch in each region is relatively small (2,460 mt and 150 mt, respectively). This bycatch would be a small proportion of the total forage biomass estimated in EBS food web models (Aydin *et al.* 2002). Lack of population-level assessments for some of the species in the forage species group means that corresponding species-level effects are unknown. FMP 3.2 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability.

Spatial and Temporal Concentration of Fishery Impact on Forage

Spatial and temporal concentration of fishery impact on forage species is assessed qualitatively by considering the potential for the alternatives to concentrate fishing on forage species in regions utilized by predators that are tied to land, such as pinnipeds and breeding seabirds. Additionally, the possibility for concentration of fishing effort to result in an ESA listing or lack of recovery to an ESA-listed species is also considered. FMP 3.1 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, resulting in an insignificant effect of the spatial/temporal concentration of the fishery on forage species. BS 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 the fur seals. FMP 3.2 would continue the existing closures around Steller sea lion rookeries with the addition of a frameworked buffer zone based on telemetry data. The existing ban on forage fish and the spatial/temporal allocation of TAC for pollock and Atka mackerel would also be continued. These measures would be improvements relative to the baseline with respect to the spatial/temporal concentration of the fisheries on forage species. Objectives and criteria for allocating TAC in space and time would be developed under this FMP. The no-trawling MPAs around the Pribilof Islands under this FMP could provide increased protection to northern fur seal foraging habitat from potential fishing effects. For these reasons, groundfish fisheries under FMP 3.2 are determined to have a conditionally significant beneficial effect on the spatial/temporal availability of forage, particularly for some marine mammals. These measures would not result in any significant change in spatial/temporal availability of forage to seabirds.

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 (minimum stock size threshold for groundfish, lead to ESA listing or prevent recovery of an ESA-listed species). Trophic level of the catch in both the BSAI and GOA is a very stable property, changing less than 3 percent on average from the baseline. Trophic level of the groundfish species for which we have age-structured models changes less than one percent on average. Under FMP 3.1, top predator bycatch amounts would increase in the BSAI (7 percent) and decrease in the GOA (12 percent) relative to the baseline. The absolute values of average catch of these species are estimated to be 724 mt and 1,150 mt in the respective regions under this FMP. For FMP 3.2, top predator bycatch amounts would decrease from the baseline in both the BSAI (27 percent) and the GOA (36 percent). The absolute values of average catch of these species are estimated to be 490 mt and 840 mt in the respective regions under FMP 3.2, the lowest amounts estimated over all the alternatives.

The above indicators result in no change in the evaluation of the importance of this effect relative to the baseline. The baseline determination was that historical whaling has resulted in low present-day abundance of whale species in the North Pacific Ocean. FMP 3.1 and FMP 3.2 would not further impair the recovery of these species through direct takes. Similarly, levels of seabird and pinniped bycatch in groundfish fisheries in these FMPs would not lead to an ESA listing for any of those populations or prevent any of the species from recovery under the ESA. Sections 4.7.7 and 4.7.8 discuss the effects of groundfish fishery direct takes on specific seabird and marine mammal populations. The effect of shark bycatch on shark populations is unknown at present, and research directed at better assessing population levels of these sensitive (late maturing, low fecundity, low natural mortality) species is needed to better assess the potential effects from groundfish fisheries. Breaking sharks out of the “Other Species” group for TAC setting means that this FMP would provide some level of increased protection for sharks through a more group-specific TAC. Section 4.6.3 contains further information on sharks. Stability in trophic level of the catch is indicative of little effect of the fishery on target species and PSC top predators (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). See Section 4.6.1 for details on these target species and Section 4.6.2 for Pacific halibut. Overall, FMP 3.1 and FMP 3.2 would have insignificant and unknown effects on top predators.

Introduction of Non-Native Species

The introduction of non-native species through ballast water exchange and hull-fouling organism release from fishing vessels could potentially disrupt Alaskan marine food web structures (Fay 2002). There have been 24 non-indigenous species of plants and animals documented primarily in shallow-water marine and estuarine ecosystems of Alaska, with 15 species recorded in PWS. It is possible that most of these introductions were from tankers or other large commercial vessels that have large amounts of ballast exchange. However, a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002) identified fishery vessels as another potential threat. Fishery vessels may take on ballast from areas where invasive species have already been established and then transit through Alaskan inshore waters. Consequently, this effect is evaluated as conditionally significant adverse in the baseline.

Total groundfish catch levels are used as an indicator of potential changes in the amount of these releases via groundfish fishery vessels (Figures H.4-27 and H.4-28 of Appendix H, Table 4.1-7). Under FMP 3.1, total catch would increase by about 2 percent in the BSAI and by about 13 percent in the GOA relative to the baseline. FMP 3.2 would result in catches increasing by about one percent in the BSAI and decreasing by 8 percent in the GOA relative to baseline. These projected catch levels are similar to recent catches in these areas, indicating a similar level of effort and thus a similar potential for fishing vessel introduction of non-native species through ballast water exchange or hull-fouling organism release. Consequently, FMP 3.1 and FMP 3.2 would result in insignificant changes from the baseline with respect to the potential for introducing non-native species from fishing vessels and gear.

Energy Flow and Balance

As discussed in Section 3.10, fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Baseline energy removals, in the form of total catch, were less than one percent of the total system energy as determined by mass-balance modeling of the system and were determined to have an insignificant impact on the ecosystem. FMP 3.1 catch removals (Figures H.4-27 and H.4-28 of Appendix H, change approximately 13 percent from the baseline 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 4.1-7). Predicted catch removals under FMP 3.2 (Figures H.4-27 and H.4-28 of Appendix H, Table 4.5-81), increase by one percent in the BSAI and decrease by 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 or fishery offal production or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the system. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms and make them more vulnerable to predation. Discards and offal production can cause local enrichment and changes in species composition or water quality if discards or offal returns are concentrated there. These effects were determined to be insignificant at the ecosystem level in the baseline. Trends in total discards (Figures H.4-29 and H.4-30 of Appendix H) under FMP 3.1 show increases by less than one percent in the BSAI and about an 8 percent decrease 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 FMP 3.2 show a 24 percent decrease in the BSAI and a 42 percent decrease in the GOA relative to the baseline. These changes are determined to be small in comparison to historical amounts of discards and are determined to have insignificant potential effects on ecosystem-level energy cycling characteristics.

Change in Species Diversity

Fishing can alter different measures of diversity. Species-level diversity, or the number of species, can be altered if fishing essentially removes a species from the system. Fishing can alter functional diversity from a trophic standpoint if it selectively removes or depletes a trophic guild member and thus changes the way biomass is distributed within a trophic guild. Functional diversity from a structural habitat standpoint can be altered if fishing methods such as bottom trawling remove or deplete organisms such as corals, sea anemones, or sponges that provide structural habitat for other species. Fishing can alter genetic diversity by selectively removing faster-growing fish or removing spawning aggregations that might have genetic characteristics that are different from other spawning aggregations. Larger, older fishes may be more heterozygous (i.e., have more genetic differences or diversity), and some stock structures may have a genetic component (Jennings and Kaiser 1998). Consequently, one would expect a decline in genetic diversity to result from heavy exploitation of a fishery.

Significance thresholds for effects of fishing on species diversity are catch removals high enough to cause the biomass of one or more species (target or nontarget) to fall below, or to be kept from recovering from levels already below, minimum biologically acceptable limits (MSST for target species, ESA listing for nontarget) (Table 4.1-7). Indicators of significance are population levels of target and nontarget species relative to MSST or ESA listing thresholds, linked to fishing removals. Bycatch amounts of sensitive (low population turnover rates) groups that lack population estimates (skates, sharks, grenadiers, and sessile invertebrates, such as corals, inhabiting HAPC may also indicate potential for fishing impact on these species (Figures H.4-31 and H.4-32 of Appendix H). Closed areas also provide protection, particularly to less-mobile species like HAPC biota, so the amount of area closures across habitat types can indicate the degree of species-level diversity protection. Baseline determinations were insignificant for most of these indicators, and unknown for skates and sharks.

Under FMP 3.1, closed areas would remain the same, and bycatch of HAPC biota would stay the same in the BSAI and decrease by almost 14 percent in the GOA. Although it is unknown whether bycatch amounts of HAPC biota would be at levels high enough to bring these species to minimum population thresholds, area closures would likely be sufficient to prevent species removal for these sessile animals. These area closures would most likely be sufficient to prevent species extinction for these sessile animals. Under FMP 3.2, bycatch of HAPC biota would decrease by about 25 percent in the BSAI and by about 40 percent in the GOA (Table 4.5-81). This FMP would also provide substantial increases in closed areas in the form of no-trawling MPAs and no-take reserves. These closures would produce even greater reductions in HAPC biota bycatch that are not modeled here. Catch amounts of target species, prohibited species, seabirds, and marine mammals resulting from both of these FMPs would be insufficient to bring species within these groups below minimum population thresholds. It is unknown whether bycatch amounts of skates, sharks and grenadiers would be at levels high enough to bring species within these groups to minimum population thresholds. Breaking sharks and skates out of the "Other Species" group for TAC setting would provide further protection by establishing additional group-specific TACs. The adoption and use of ecosystem indicators for modifying TAC may also provide further protection to sensitive groups such as these until more is learned about their life histories. Although forage species population levels are not known, their relatively high turnover rates and the ban on forage fish fisheries in these FMPs are considered sufficient protection from population-level effects.

On the basis of the preceding considerations, FMP 3.1 and FMP 3.2 are considered to result in insignificant and unknown effects on species diversity. More years of survey data and life history parameter determination for skates, sharks and grenadier species may better define population trends as to further protect these species from experiencing adverse impacts from fishing. Sections 4.7.1 though 4.7.8 present the detailed analyses of the potential for fishery removals to affect minimum population thresholds for each of these groups and thus to ultimately affect species diversity.

Change in Functional Diversity

Functional (either trophic or structural habitat) diversity can be altered through fishing if fishing selectively removes one member of a functional guild, which may result in increases in other guild members. A functional guild is a group of species that use resources within the ecosystem in similar ways. Significance thresholds are catch removals high enough to cause a change in functional diversity outside the range of natural variability observed for the system (Table 4.1-7). Indicators of the possible magnitude of effects include qualitative evaluation of guild or size diversity changes relative to fishery removals, bottom gear effort changes that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild. Members of the HAPC biota guild serve important functional role in providing fish and invertebrates with habitat and refuge from predation. The abundance of these structural species necessary to provide protection is not known, and it may be important to retain populations of these organisms that are well distributed spatially in order to fulfill their functional role. Some of these organisms have life-history traits that make them very sensitive to fishing removals. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Present-day Steller sea lion trawl closures are spread throughout the Aleutian chain, but these closures may be more inshore than most of the coral. For this reason, the areas closed to trawling in this FMP may not be sufficient to provide additional protection beyond the baseline for these sensitive organisms.

Under FMP 3.1, the species composition and amounts of removals, bottom gear effort, and bycatch amounts of HAPC biota (Table 4.5-81, Figures H.4-31 and H.4-32 of Appendix H) would be relatively 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 FMP 3.2 have been designed with corals in mind and, if implemented, will ensure that there is a broad spatial distribution of corals, particularly in the Aleutian Islands. Thus, FMP 3.2 is determined to have a significantly beneficial effect relative to the baseline on structural habitat diversity while FMP 3.1 would result in is an insignificant change from the baseline. In addition, FMP 3.2 is determined to have a insignificant effect on trophic diversity, species composition, and amounts of removals for target species relative to the baseline.

Change in Genetic Diversity

Genetic diversity can be affected by fishing through heavy exploitation of certain spawning aggregations or systematic targeting of older age classes that tend to have greater genetic diversity. Under FMP 3.1 and FMP 3.2, no target species would fall below MSST, spatial/temporal management of TAC would not change, and similar catch and selectivity patterns in the fisheries would apply. These FMPs would result in insignificant impacts of fishing on genetic diversity. However, a baseline condition for genetic diversity remains unknown for most species and the potential effects that fishing may have on genetic diversity under FMP 3.1 and FMP 3.2 are also largely unknown.

Cumulative Effects Analysis FMP 3.1 – Ecosystems

The following sections briefly discuss the potential cumulative effects of FMP 3.1 on the ten ecosystem indicators explained in Section 4.5.10. These potential cumulative effects are summarized in Table 4.7-7. 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 effects of FMP 3.1 on pelagic forage availability are expected to be insignificant. Fishery-induced changes, including bycatch-related effects on forage species, would be within the natural level of abundance or variability for prey species relative to predator demands (Table 4.1-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability would occur in the event of a large petroleum spill. The conditions under which this effect would be significant relate to the areas affected by, and seasonal timing of, the spill. If these coincide with spawning locations and times, a significantly adverse cumulative effect on pelagic forage availability would most likely result. Additive or interactive contributions from State of Alaska commercial fisheries and subsistence fish harvests are not expected to be significant. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The direct/indirect effects of the spatial/temporal concentration of fishing efforts under FMP 3.1 on pelagic forage availability are expected to be insignificant. FMP 3.1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial/temporal allocation of TAC of pollock and Atka mackerel, which have been determined to result in an insignificant impact on spatial/temporal concentration of fishery on forage species.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may have persisted into the present and future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlapping with the groundfish fishery is more likely temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing efforts and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines and adversely impact other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that are synergistic with spatial/temporal concentrations of fishing efforts, in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring, and subsistence fish harvests, converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species in ways that might reduce or intensify this potential cumulative effect.

Removal of Top Predators

- **Direct/Indirect Effects.** The implementation of FMP 3.1 is predicted to have insignificant effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This FMP would not impair the continued recovery of whale populations still reduced through direct take in the past, and levels of seabird and marine mammal bycatch in the groundfish fisheries would not lead to any of these species being listed, 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 low present-day abundance of whale species in the North Pacific. State of Alaska directed groundfish fisheries, which are small and sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have had a sustained effect on some populations that persist today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result primarily from continued high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch will continue in the future. The conditions under which this cumulative effect could be significant are the continuation of high external seabird bycatch rates in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and this could intensify or reduce the potential cumulative effect by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** Under FMP 3.1, projected catch levels would maintain about the same potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms that currently exists under baseline conditions. Therefore, the direct/indirect effect of FMP 3.1 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with FMP 3.1, it is conceivable that viable populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that might allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA. 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 may establish viable runs at some point in the reasonably foreseeable future (ADF&G 2002a).

Energy Removal

- **Direct/Indirect Effects.** The effects of FMP 3.1 on energy removal are expected to be insignificant. Baseline energy removals, in the form of total catch, are less than one percent of the total ecosystem energy, as estimated by mass-balance modeling, and were determined to have an insignificant impact on the ecosystem. Total retained catch removals under FMP 3.1 are still less than one percent of the total system energy as estimated from mass-balance modeling for the EBS. Therefore, estimated energy removals under FMP 3.1 would not have the potential to produce changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 3.1 is predicted to have an insignificant cumulative effect on energy removal in the future. The total domestic groundfish catch under this FMP is estimated to remove less than one percent of the total system energy. If the annual total catches of the State of Alaska herring and crab and IPHC halibut fisheries in the future are similar to the 1997-2001 averages, the combined total catch of these external fisheries will represent an approximate 6 percent addition to the estimated total catch for the groundfish fisheries alone under this FMP (Table 4.5-81). This additional increment of biomass removal is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability due to expected energy removals by the BSAI and GOA groundfish fisheries (Table 4.1-7).

Energy Redirection

- **Direct/Indirect Effects.** The effects of FMP 3.1 on energy redirection are expected to be insignificant. Predicted effects would be small relative to the baseline and would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 3.1 is predicted to have an insignificant cumulative effect on energy redirection. The cumulative effect in combination with these 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 EPA and ADEC permitting programs.

Change in Species Diversity

- **Direct/Indirect Effects.** The expected direct/indirect effects of FMP 3.1 on species diversity are rated as unknown for skates, sharks, and grenadiers and insignificant for other groups. Under FMP 3.1, closed areas would remain the same, and bycatch of HAPC biota would stay the same in the BSAI and decrease by almost 14 percent in the GOA (Table 4.5-81). Although it is unknown whether bycatch amounts of HAPC biota would be at levels high enough to bring these species to minimum population thresholds, area closures would likely be sufficient to prevent species removal for these sessile animals. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show positive correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, 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 and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 3.1, a conditionally significant adverse effect on species diversity could result from a cumulative high level of seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may, at some time in the future, establish a viable population that could change species diversity in an adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species. Under some combination of these conditions, the biomass of one or more species could fall below, or be kept from recovering from levels already below, minimum biologically acceptable limits (Table 4.1-7).

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Under FMP 3.1, the predicted 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, the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 3.1 could produce a conditionally significant adverse effect on trophic diversity. The primary condition for this effect is largely speculative: a climatic regime shift could make a trophic guild containing one or more 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 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 could decrease their representation within trophic guilds. This would particularly affect slow-growing species such as the rockfishes that are taken by bottom trawl, are subject to removal as bycatch, and have been reduced by overfishing in the past (Heifitz *et al.* 2001).

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to functional diversity in terms of structural habitat is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures for habitat of other species, including economically important groundfish species and their prey. Present (comparative baseline) trawl closures to protect the Steller's sea lion are spread throughout the Aleutian chain, but these closures are in waters shallower than where corals tend to be found. In FMP 3.1, the species composition and amounts of removals, bottom gear effort and bycatch amounts of HAPC biota, and areas closed to trawling relative to coral distribution are relatively similar to the baseline. Therefore, the change from baseline conditions that would result from 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 from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of FMP 3.1, 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 fishery on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity, and thus the population size, as well as the distribution, of bottom-dwelling invertebrates that provide structural habitat.

Change in Genetic Diversity

- **Direct/Indirect Effects.** Under FMP 3.1 it is not expected that target species would fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to the comparative baseline conditions. Consequently, the effect of the groundfish fisheries on genetic diversity are expected to be insignificant under this FMP. However, baseline genetic diversity remains unknown for most species and the actual direct/indirect effects that fishing would 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, the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 3.1 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. Thus, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

Cumulative Effects Analysis FMP 3.2 – Ecosystems

The following sections briefly discuss the potential cumulative effects of FMP 3.2 on the ten ecosystem indicators explained in Section 4.5.10. These potential cumulative effects are summarized in Table 4.7-7. Data and calculations supporting the energy removal analyses for the alternatives are presented in Table 4.5-81.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The effects of FMP 3.2 on pelagic forage availability are expected to be insignificant. Fishery-induced changes, including bycatch-related effects on forage species, would be within the natural level of abundance or variability for prey species relative to predator demands (Table 4.1-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below the threshold level (MSST). Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability would occur in the event of a large petroleum spill. The conditions under which this effect could be significant relate to the areas affected by, and seasonal timing of, the spill. If these coincide with spawning locations and times, a significantly adverse cumulative 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/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentration of fishing efforts under FMP 3.2 on pelagic forage availability are expected to be conditionally significant beneficial for all predatory groups except seabirds, for which the effects are expected to be insignificant relative to the baseline. FMP 3.2 would continue the existing closures around Steller sea lion rookeries but add a buffer zone based on telemetry data. It would also maintain the existing ban on forage fish and the spatial/temporal allocation of TAC of pollock and Atka mackerel. Objectives and criteria for allocating TAC in space and time would be developed and may have more discriminating space/time

TAC allocations of forage to provide increased protection against the fisheries' ability to localize and deplete concentrations of prey species. 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.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may have persisted into the present and future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlapping with the groundfish fishery is more likely temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines and adversely impact other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that are synergistic with spatial/temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring, and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species in ways that might reduce or intensify this potential cumulative effect.

<u>Removal of Top Predators</u>

- **Direct/Indirect Effects.** The implementation of FMP 3.2 is predicted to have insignificant effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This FMP would not impair the continued recovery of whale populations still reduced through direct take in the past, and levels of seabird and marine mammal bycatch in the groundfish fisheries would not lead to any of these species being listed, or prevent their recovery 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 sharks, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific. State of Alaska directed groundfish fisheries, which are small and sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have had a sustained effect on some populations that persist today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result primarily from continued high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch will continue in the future. The conditions under which this cumulative effect could be significant are the continuation of high external seabird bycatch rates in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and this could intensify or reduce the potential cumulative effect by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** Under FMP 3.2, the predicted catch levels indicate that this FMP would maintain 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 FMP 3.2 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 waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with FMP 3.2, it is conceivable that viable populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that might allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA. 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 may establish viable runs at some point in the reasonably foreseeable future (ADF&G 2002a).

Energy Removal

- **Direct/Indirect Effects.** The effects of FMP 3.2 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. The predicted catch removals for the BSAI and GOA are still less than one percent of the total system energy as estimated from mass-balance modeling for the EBS. Therefore, estimated energy removals under FMP 3.2 would not have the potential to produce changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 3.2 is predicted to have an insignificant cumulative effect on energy removal in the future. If the combined total catch of the State of Alaska herring and crab and IPHC halibut fisheries in the future is similar to the 1997-2001 average, the cumulative total catch of these external fisheries plus the BSAI and GOA groundfish fisheries will increase by about 6.2 percent over the estimated total catch for FMP 3.2 alone (Table 4.5-81). This additional increment of biomass removal is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability due to expected energy removals by the BSAI and GOA groundfish fisheries (Table 4.1-7).

Energy Redirection

- **Direct/Indirect Effects.** The effects of FMP 3.2 on energy redirection are expected to be insignificant. These effects were determined to be insignificant at the ecosystem level in the baseline, and projected trends in total discards modeled for FMP 3.2 would decrease from the baseline by about 24 percent increase in the BSAI and 42 percent decrease in the GOA (Table 4.5-81). These effects, while decreasing the amount of energy redirected by discards, would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 3.2 is predicted to have an insignificant cumulative effect on energy redirection. Even with the substantial decreases in discards predicted (Table 4.5-81), the cumulative effect of FMP 3.2 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 EPA and ADEC permitting programs.

Change in Species Diversity

- **Direct/Indirect Effects.** The expected effects of FMP 3.2 on species diversity are rated as unknown for skates, sharks, and grenadiers and insignificant for other groups. Under FMP 3.2, bycatch of

HAPC biota would decrease by about 25 percent in the BSAI and by about 40 percent in the GOA (Table 4.5-81). This FMP would also provide substantial increases in closed areas in the form of no-trawling MPAs and no-take reserves. These area closures would most likely be sufficient to prevent species extinction for these sessile animals. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds. Although forage species population levels are not known, their relatively high turnover rates and the ban on forage fish fisheries in 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 (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show positive correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, 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 and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 3.2, a conditionally significant adverse effect on species diversity could result from a high level of seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may establish a viable population that would change species diversity in a adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species.

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 FMP 3.2, the predicted 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, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 3.2 could produce a conditionally significant adverse effect on trophic diversity. The primary condition for this effect is largely speculative: a climatic regime shift could make a trophic guild containing one or more 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 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, could decrease their representation within trophic guilds. This would particularly affect slow-growing species such as the rockfishes that are taken by bottom trawl, are subject to removal as bycatch, and have been reduced by overfishing in the past (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, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures used as habitat of other species, including economically important groundfish species and their prey. FMP 3.2 is determined to have a significantly beneficial effect relative to the baseline on structural habitat diversity. Some of the area closures for this FMP have been designed with corals in mind and, if implemented, will ensure that there is a broad spatial distribution of corals, particularly in the Aleutian Islands. Also, bottom trawl effort would most likely decline, and area closures would provide additional protection to benthic communities.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data, no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of FMP 3.2, 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 FMP 3.2 could be offset under any of the following three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could affect, to an unknown extent, some of the benefits of FMP 3.2 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 FMP 3.2 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 effect of the groundfish fisheries on genetic diversity are expected to be insignificant under this FMP. However, baseline genetic diversity remains unknown for most species and the actual effects that fishing would 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, the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 3.2 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. Thus, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

4.7.11 Summary of Alternative 3 Analysis

The direct, indirect and cumulative ratings for all resource categories analyzed under this alternative are summarized in Table 4.7-7.

Table number	Resource category	Components	Section 4.7 reference
4.7-1	Target groundfish species	Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) walleye pollock, BSAI and GOA Pacific cod, BSAI and GOA sablefish, BSAI and GOA Atka mackerel, BSAI yellowfin sole, GOA shallow water flatfish, BSAI rock sole, BSAI and GOA flathead sole, BSAI and GOA arrowtooth flounder, BSAI Greenland turbot, GOA deepwater flatfish, BSAI Alaska plaice, BSAI other flatfish, GOA rex sole, BSAI and GOA Pacific ocean perch, GOA thornyhead rockfish, BSAI and GOA northern rockfish, BSAI and GOA shortraker/rougheye rockfish, BSAI other rockfish, GOA slope rockfish, GOA pelagic shelf rockfish, GOA demersal shelf rockfish	4.7.1
4.7-2	Prohibited, other, forage and non-specified species	Pacific halibut, Pacific salmon and steelhead trout, Pacific herring, crab Other species category Forage fish category Grenadier	4.7.2 4.7.3 4.7.4 4.7.5
4.7-3	Habitat	BSAI, GOA	4.7.6
4.7-4	Seabirds	Black-footed albatross, Laysan Albatross, Short-tailed albatross, northern fulmar, shearwaters, storm-petrels, cormorants, spectacled eider, Steller's eider, jaegers, gulls, kittiwakes, terns, murres, guillemots, murrelets, auklets, puffins	4.7.7
4.7-5	Marine mammals	Steller sea lion, northern fur seals, Pacific walrus, harbor seals, spotted seal, bearded seal, ringed seal, ribbon seal, northern elephant, sea otter, blue whale, fin whale, sei whale, minke whale, humpback whale, gray whale, northern right whale, bowhead whale, sperm whale, beaked whales (Baird's, Cuvier's and Stejneger's), Pacific white-sided dolphin, killer whale, beluga whale, harbor porpoise, Dall's porpoise	4.7.8
4.7-6	Socioeconomics	Harvesting and processing sector (catcher vessels, catcher processors, inshore processors and motherships) Regional socioeconomic profiles (population, processing ownership and activity, catcher vessel ownership and activity, tax revenue, employment and income) CDQ allocations Subsistence (subsistence use of groundfish, subsistence use of Steller sea lions, salmon subsistence fisheries, indirect subsistence factors: income and joint production) Environmental justice Market channels and benefits to U.S. consumers (product quantity, product year-round availability, product quality, product diversity) Non-market goods (benefits derived from marine ecosystems and associated species)	4.7.9.1 4.7.9.2 4.7.9.3 4.7.9.4 4.7.9.5 4.7.9.6 4.7.9.7
4.7-7	Ecosystem	Forage fish availability, spatial/temporal concentration of fisheries, introduction of non-native species, removal of top predators, energy redirection, energy removal, species diversity, guild diversity, genetic diversity	4.7.10