Chapter 4: Environmental and economic consequences of the alternatives

Chapter 4 examines the environmental and economic consequences that are expected to result from adoption of each of the alternatives. A comparison of each alternative to the environmental baseline will be made in order to assess the effects of each alternative. Broader issues such as the effects of crab fishing in general and the cumulative effects of crab fishing in the Bering Sea and Aleutian Islands (BSAI) are also addressed in this environmental impact statement (EIS).

The task of describing how a particular fishery is expected to conduct itself under a comprehensive new set of rules involves some degree of conjecture and speculation. This is because the circumstances that lead fishermen and the industry to behave in a certain manner are dependent on such a wide variety of unpredictable factors including weather patterns, sea ice conditions, the migratory patterns of the target species, worldwide market conditions, other regulatory changes, and a host of other factors that are difficult or impossible to predict. Nevertheless, the re-organization of the BSAI crab fishery under each alternative would result in certain predictable changes to fishing and processing practices, and these changes will have some predictable environmental and economic consequences.

Section 4.1 describes the structural and organizational changes to the fishery that are expected to result from each of the alternatives and how these changes are expected to affect fishing and processing patterns. The most significant organization change to the BSAI crab fisheries is the emergence of harvester quota shares which would eliminate the race for fish and would allow for rationalization of the fishery. Significant structural changes resulting from the rationalization program alternatives include: establishing processor quota shares, cooperatives, binding arbitration, measures for distributing quota shares to captains and crew, community protection measures, and increases in community development quota (CDQ) allocations. In response to these organizational and structural changes, the State of Alaska (State) would make changes to the management of the BSAI crab fisheries.

These major structural and organizational changes are expected to affect patterns of crab fishing and processing in the BSAI. Among the possible changes examined in this chapter are:

- **Effects on crab fishing patterns.** How will each of the alternatives affect when and where crab fishermen choose to fish?

- **Effects on fleet composition.** How will each of the alternatives affect the composition of the various crab fishing fleets?

- **Effects on crab processing patterns.** How will each of the alternatives affect crab processing (i.e., processing locations, product forms, and recovery rates)?

The conclusions with respect to fishing patterns, processing patterns, and fleet composition detailed in Section 4.1 form the basis for an analysis of potential effects of each of the alternatives on the crab stocks in Section 4.2, and an analysis of the potential effects of each of the alternatives on other biological resources in Section 4.3. Effects on managed fishery resources, benthic habitat, marine mammals, seabirds, endangered and threatened species, other species, and cumulative effects on the environment are examined in these sections. Section 4.4 examines the effects to essential fish habitat (EFH). Section 4.5 presents the predicted effects of the alternatives on the BSAI ecosystem. Section 4.6 examines the economic and socioeconomic effects of the alternatives. These include impacts to crab and non-crab fisheries, impacts to coastal communities, impacts to consumers, and other economic and socioeconomic effects of the alternatives. Economic effects of the alternatives are also addressed in the regulatory impact review and the initial regulatory flexibility analysis (RIR/IRFA) contained in Appendix 1. Effects of the alternatives on communities are also addressed in the Social Impact Assessment (SIA) contained in Appendix 3. Section 4.7 addresses environmental justice considerations and examines the effects of the alternatives on minority and low-income populations. Section 4.8 addresses the energy requirements and conservation potential of the alternatives. Section 4.9 is a discussion of the cumulative effects of the alternatives, and Section 4.10 is a summary of the consequences of each alternative.

As a starting point, each alternative under consideration is perceived as having the potential to significantly affect one or more components of the human environment. Significance is determined by considering the context in which the action will occur and the intensity of the action. The context in which the action will occur includes the specific resources, ecosystem, and the human environment affected. The intensity of the action includes the type of impact (beneficial versus adverse), duration of impact (short versus long term), magnitude of impact (minor versus major), and degree of risk (high versus low level of probability of an impact occurring). Further tests of intensity include: 1) the potential for jeopardizing the sustainability of any target or non-target species; 2) substantial damage to ocean and coastal habitats and or essential fish habitat; 3) impacts on public health or safety; 4) impacts on endangered or threatened species, or critical habitat of these species; 5) cumulative adverse effects; 6) impacts on biodiversity and ecosystem function; 7) significant social or economic impacts; and 8) degree of controversy (NAO 216-6, Section 6.02).

Differences between direct and indirect effects are primarily linked to the time and place of impact. Direct effects are caused by the action and occur at the same time and place. Indirect effects occur later in time and/or further removed in distance from the direct effects (40 CFR 1508.27). For example, the direct effects of an alternative which lowers the harvest level of a targeted fishery could include a beneficial impact to the targeted stock of fish, a neutral impact on the ecosystem, and an adverse impact on net revenues to fishermen, while the indirect effects of that same alternative could include beneficial impacts on the ability of Steller sea lions to forage for prey, neutral impacts on incidental levels of prohibited species catch, and adverse impacts in the form of multiplier effects reducing employment and tax revenues to coastal fishing communities.

The terms effects and impacts are used interchangeably. The Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of the National Environmental Policy Act (NEPA), state "Effects and impacts as used in these regulations are synonymous" (40 CFR §1508.8). The terms positive and beneficial are also used interchangeably to indicate direction of intensity in significance determination, as are negative and adverse.

Each section in this Chapter contains an explanation of the criteria used to establish significance and a determination of significance, insignificance or unknown for each resource, species, or issue being treated. The following ratings for significance are used; significant (beneficial or adverse), insignificant, and unknown. Definitions of the criteria used for these rankings are included in each section. Where sufficient information is available, the discussions and rating criteria used are quantitative in nature. In other instances, where less information on the direct and indirect effects of the alternative are available, the discussions and rating criteria used are qualitative in nature. The generic definitions for the assigned ratings are as follows:

S+ Significant beneficial effect in relation to the baseline; this determination is based on ample information and data and the judgement of NOAA Fisheries analysts who addressed the topic.

S- Significant adverse effect in relation to the current population trajectory and based on ample information, data, and the judgement of the NOAA Fisheries analysts who addressed the topic.

I Insignificant effect in relation to the current population trajectory; this determination is based upon information and data, along with the judgement of NOAA Fisheries analysts, which suggests that the effects are small and within normal variability.

U Unknown effect; this determination is characterized by the absence of information and data. In instances where the information available is not adequate to assess the significance of the impacts on the resource, species, or issue, no significance determination was made, rather the particular resource, species, or issue was rated as unknown.

NA Not Applicable. In instances where the full spectrum of significant negative, insignificant, and significant positive are not logically described, the undescribable situation is noted not applicable.

When information is incomplete or unavailable to quantify an impact's significance (beneficial or adverse), or if the point at which an effect becomes significant is not supported by scientific data, the impact's significance is qualified and the incomplete or unavailable information is noted. This implies that significance is assumed, based on the credible scientific information and professional judgement that are available, but more complete information is needed for certainty. In other words, researchers may believe that an impact has a significant adverse or a significant beneficial effect, but not have a high level of certainty about that finding. This approach provides a heightened sense of where information is lacking, and may guide research efforts in the future.

4.1 Predicted effects of the alternatives on BSAI crab fisheries

Rationalization program alternatives under consideration represent a dramatic restructuring and reorganization of the BSAI crab fisheries. These changes are expected to modify the crab fishing patterns in ways that could have environmental and economic consequences. Changes to the prosecution of the fisheries would be realized through changes to the State management of these fisheries, changes in fleet composition and fishing practices, and changes to processing practices. Changes to State management that would result from implementing the alternatives are discussed in Section 4.1.1. Changes to State management include predicted changes to improve the management of the fisheries under the alternatives. Section 4.1.2 describes the predicted changes to fleet composition and fishing practices, including changes to vessels, vessel owners, captains, and crew, that would result from the alternatives. Section 4.1.3 describes projected changes to processing practices for shore-based processors, floating processors, and catcher/processors (C/P), that would result from the alternatives. Section 4.1.4 describes summarized biological effects from selected rationalization programs throughout the world.

4.1.1 Projected changes to State management of BSAI crab fisheries

Alaska Department of Fish and Game (ADF&G) provided the following analysis of projected changes to State management of the BSAI crab fisheries. The EIS considers four alternatives. These include operating under the status quo where the race for fish continues (a derby-style fishery), a three-pie voluntary cooperative (Alternative 2), an individual fishing quota (IFQ) program (Alternative 3), and a cooperative program (Alternative 4). The North Pacific Fisheries Management Council (Council) selected a preferred alternative, addressing a three-pie approach (harvesters, processors, and communities) to rationalization of these crab fisheries. The stated intent of the preferred alternative is to address Council objectives for rationalizing an overcapitalized fishery.

The ADF&G manages the crab fisheries in the BSAI areas according to management measures established in the federal FMP for BSAI king and Tanner crabs. Status quo management measures are described in section 2.1.4. The FMP defers much of the management of the BSAI crab fisheries to the State using the following three categories of management measures:

- those that are fixed in the FMP and require a FMP amendment to change;
- those that are framework-type measures that the State can change following criteria set out in the FMP; and
- those measures that are neither rigidly specified nor frameworked in the FMP.

Category 2 management measures include minimum size limits; guideline harvest levels (GHL); inseason adjustments; district, subdistrict, and section boundaries; fishing seasons; sex restrictions; pot limits; registration areas; and closed waters.

Category 3 management measures include reporting requirements, gear placement and removal, gear storage, vessel tank inspections, gear modifications, bycatch limits, State observer requirements, and others.

Management measures in Categories 2 and 3 may be adopted under state laws subject to the appeals process provided for in the federal FMP. The Board of Fisheries (BOF) is authorized under Alaska Statute (AS) 16.05.251 Regulations of the BOF to adopt regulations it considers advisable in accordance with the State Administrative Procedures Act. These regulations cover a broad scope of themes and issues, including open and closed seasons, quotas, sex and size limitations, legal gear, etc.

Under alternatives 2, 3, and 4, rationalization of the BSAI crab fisheries would result in BOF review of possible regulatory actions to accommodate anticipated changes in the prosecution of rationalized fisheries. Management measures that are likely to be affected include those listed as Category 2 or Category 3 measures within the FMP. This analysis of projected changes to State management of the BSAI crab fisheries assumes that the FMP management structure and the three categories of management measures will remain the same under each alternative.

State management measures that would not likely change as a result of rationalization would include the following Category 2 measures: minimum size limits (a reasonably established biological metric to protect subadults, and a reasonably established metric under all alternatives); districts, subdistricts, and sections (reasonably established and linked to historical catch and participation data); sex restrictions (a biological element to protect spawning stock under all alternatives); and closed waters (a reasonably established biological element to protect juveniles and females or their critical habitat under all alternatives).

The BOF process is not inherently proscriptive; it is reactive based upon State and Federal fishery data and industry information presented during annual meetings. The BOF must formally consider a series of criteria to form regulations in any fishery, including; resource conservation, environmental concerns and allocation of the resource. As such, this multi-objective framework does not lend itself to predicting precise BOF management changes or the causes and effects of future BOF actions.

To satisfy the intent of the NEPA and other rule making requirements, this analysis will:

- identify the probable choice set of management tools typically used by the BOF in the crab fisheries;

- provide a qualitative assessment of the probability of each management tool; and

- identify, to the extent practicable the direction of change in the associated effects, including the relevant issues identified in this EIS.

Discussion of changes to outcomes analyzed herein is dependent upon the three alternatives considered in the EIS and the decision of the BOF during the public process. ADF&G has identified the following as potential effects to changes in management measures: lost pots in each fishery, vessel participation, pot soak durations, bycatch, highgrading, deadloss, the rate of rebuilding overfished crab stocks, and spillover effects into other fisheries. These management measures are discussed in the order they appear in the FMP, and not in their significance to current management of the BSAI crab resources, nor associated issues of concern with those resources.

Alternative 1 Status quo

Guideline harvest level. The BSAI crab fisheries are currently managed using a GHL. A preseason GHL is developed from the summer survey or estimated in unsurveyed stocks from past fishery performance. Total catch and catch per unit effort (CPUE) are monitored inseason. In most seasons, harvest rates are similar to those projected and the season closure determined based on the estimated time that the GHL will be fully harvested. If the CPUE and total catch indicate that resource abundance is below that projected in the fishery, the fishery might be closed prior to achieving the GHL. This system allows ADF&G the discretion to limit harvests below the GHL, if necessary to protect the resource. Due to biologically depressed crab stocks and high fishing capacity, most GHLs are now treated as the season total allowable catch (TAC), and estimates of catching power and fleet participation are used to inform the fleet about an imminent fishery closure.

The following factors are FMP criteria, and will be considered to the extent information is available in establishing GHLs:

- estimates of exploitable biomass;
- estimates of recruitment;
- estimates of threshold;
- estimates of maximum sustainable yield (MSY) or optimum yield (OY); and

- market and other economic considerations.

The sum of all upper ranges of the GHLs for king crabs and both species of Tanner crab must fall within the OY ranges established in the FMP.

Crab fisheries operating under the status quo would continue to fish toward an established GHL. Under this scenario, with stock abundance low in most crab fisheries, the possibility of overharvest continues to exist given the short seasons and continued race for fish.

Inseason adjustments. ADF&G is able to make inseason adjustments to the commercial crab fisheries when an event occurs that affects preseason predictions, or when inseason assessment indicates that a preseason prediction is incorrect. Under authority granted to ADF&G by the Alaska Legislature (A.S. 16.05.060. Emergency Orders) and the FMP, ADF&G is authorized to make inseason adjustments to the GHLs, to fishing period lengths, and to closed areas under state regulations. These compensatory inseason adjustments must be made to keep the management system on track toward meeting the biological and economic objectives of the FMP. Managers make inseason adjustments to the GHL when inseason fishery performance suggests population abundance is either over or under-estimated from the survey. Sources of error are imprecise estimates such as survey error or unexpected mortality. Inseason adjustments to the GHL rely upon a long baseline of fishery performance data and on-grounds reporting. However in recent years stocks have been depressed. GHLs and harvest rates were low, so adjustments have not been made. This has made reliance on historic baseline data and fishery performance reports from fisheries inseason difficult. Short seasons, large fleet participation levels and changing fishery strategies make inseason adjustments questionable. Newer harvest strategies for several BSAI crab stocks have lower exploitation rates to address the survey-error and other mortality issues. Note that the only time the fishery closed significantly early before the GHL was reached was in the Tanner crab fishery when the survey indicated a large number of legal crab, but the fleet could only find a small number of marketable crab. The survey indicating a biologically available harvest was correct, but the crab on the grounds were dirty (not marketable). As a result, the fleet petitioned ADF&G managers to stop the fishery early so as to not destroy markets with a plethora of unmarketable crab. Under the status quo, ADF&G's ability to make necessary inseason adjustments would continue.

Seasons. If the BSAI crab fisheries continue to operate under status quo management, the BOF is likely to employ many of the management tools that they have utilized under the existing fisheries. Season length, through the BOF regulation adoption process, is expected to remain short when stocks are low in abundance, and increase as stocks rebuild. The race for fish will continue under all levels of abundance, with all the problems (gear loss, elevated bycatch levels, deadloss, safety, etc.) associated with fisheries conducted in a derby style. The race for fish has often resulted in managers exceeding the GHL. If seasons continue under the status quo, the effects that have occurred in the existing fisheries would be highly likely to continue.

Status quo season length will also promote continuation of current deadloss and bycatch rates as fishermen race through the season under derby-style fisheries. During derby-style fisheries, pots are retrieved with minimal soak time. With short soak times escape mechanisms, such as escape rings or large mesh panels, are not fully effective because fresh bait keeps sublegal and female crab from leaving the crab pot. In a status quo fishery, the time that pots are allowed to soak on bottom is primarily a function of the current pot limits allowed per vessel, number of vessels on the grounds, and the duration of the fishery as expected from the GHL. Weather, largely unpredictable in this area, also factors into season length. Season length may influence pot soak times. If future seasons operate similarly to past seasons, the amount of time a crab pot remains on the bottom will depend on weather, season length, the GHL and the pot limit. This is not expected to change under the status quo. Crab stocks would be subject to similar catch, bycatch, and handling characteristics. It has been demonstrated that reductions in soak time make escape mechanisms less effective in reducing bycatch of undersized animals. Deadloss in derby-style fisheries is partially caused by the speed of operations. The derby-style fishery promotes rough handling of crab and can cause injuries. Those injured crab are more likely to die.

Pot limits. Pot limits have been put in place to address excess harvest capacity, however, pot limits have resulted in economic inefficiencies in the fleet. During the early 199Bering Sea, BSAI crab fisheries were characterized by increasing fishing effort, decreasing GHLs, and shorter fishery seasons. Responding to these concerns the BSAI crab industry submitted a petition to the BOF requesting them to consider limiting the number of pots deployed in BSAI crab fisheries. Data from ADF&G supported this petition for pot limits. The data indicated significant crab pot gear deployment was creating conservation and management difficulties. Too many pots were being fished by some fishermen to assure their retrieval and reduce pot loss; excess pots were saturating the grounds, causing grounds preemptions and pot loss due to grounds crowding (vessels were running over each others' buoy lines and cutting them).

On March 20, 1991, the BOF proposed an agenda change request to discuss this issue. In 1992 they adopted regulations limiting the number of pots a vessel may operate while harvesting Bering Sea king and Tanner crabs, effective August 1, 1992. The buoy tag identification program was designed to help implement these regulations. On November 30, 1992, NOAA Fisheries repealed Bering Sea pot limits due to inconsistency with the National Standards that require all regulations to be applied in a nondiscriminatory manner. Pot limits are a FMP Category 2 management measure, thus they may be adopted at the state level, but are subject to the federal appeals process. As a result, in February 1993, the BOF passed differential pot limit regulations based on vessel length overall (LOA). According to these regulations, vessels in excess of 125 feet LOA are entitled to operate the maximum number of pots allowed for a fishery, and vessels 125 feet or less LOA may fish 80 percent of the maximum pot limit.

On August 27, 1997, interim pot limit regulations were adopted for harvesting Bristol Bay red king crab. The regulations outlined an eleven-tier pot limit program dependent on fishery GHL and vessel pre-registration and were made permanent in March 1999.

Pot limits are currently in place in most BSAI crab fisheries. Existing pot limits would likely remain in place if the fisheries continue to be managed under the status quo alternative. Pot loss would continue due to several reasons. In crab fisheries conducted in the winter, pot loss occurs due to interaction with the Bering Sea pack ice. Pack ice can move quickly and often times pots are set near the ice edge because of the abundance of crabs. Fishermen may not be able to react in a timely manner to rapidly advancing pack ice to move their entire complement of gear, or at other times when they may be in port making deliveries. Lost pots can also occur due to interaction with vessels working in crowded locations. While the current conservative pot limit has addressed excess gear loss, vessels, especially in poor weather, may inadvertently cut off crab buoys as they maneuver among gear. Pots are designed with biodegradable escape mechanisms to permit the release of captured crab and other fish in derelict gear. However, these escape mechanisms take at least 30-days and perhaps longer to effectively allow release. Pot loss can also occur due to interaction with other fisheries using mobile gear types. In past years, interaction has occurred between pot gear and trawl gear.

Registration areas. Registration areas will remain the same under the status quo. Current areas in use by the state were adopted into the FMP. Registration areas are characterized by relatively homogeneous established fisheries on stocks of crab that have insignificant transfer of adults between areas. These stocks tend to be fished by the same general class of vessels from year to year, with seasons varying somewhat from area to area due to natural causes, such as differences in timing of molting and breeding. Geographic remoteness from processing plants and support facilities may further characterize some areas. BOF regulations require vessels to register for fishing in these areas, and may require vessels to register for specific fishing districts within a registration area. Registration requirements allow estimation of fishing effort and the rate at which the resource will be harvested. Under the status quo, the BOF will continue to designate areas as either non-exclusive, exclusive or super-exclusive. Vessels can register for any one exclusive area and are not restricted in their choice, but cannot fish in any other exclusive area during the registration year. They can, however, fish any or all other non-exclusive areas. The use of exclusive area designations is an aid in dispersing fishing effort. Exclusive registration areas can help provide economic stability to coastal communities or to segments of the industry dependent on an individual registration area's crab stocks. Particularly if the character of the fishing fleet and the related industry participants, depending upon the registration area's potential production, would not allow movement to another registration area. This is particularly advantageous to the less mobile vessels if the area in which they fish is not the most profitable area for the more mobile vessels.

Reporting requirements. Reporting requirements exist to address biological and enforcement concerns. Reporting requirements include those for catchers and processors, and are important components in achieving the biological conservation, economic, social, research and management objectives of the FMP. Reporting requirements and other FMP Category 3 management measures were addressed in detail in Section 2.1.3. Under status quo management, no changes would be anticipated to existing reporting requirements. These requirements would continue to benefit the overall health of the crab resources in the area.

Gear placement and removal. Currently, the BOF has specific gear placement and removal requirements to ensure fair start and to address enforcement concerns. If the status quo is maintained, no changes to resource health would be expected.

Gear storage. Similar to gear placement and removal requirements, the BOF has created regulations for gear storage under the FMP Category 3 management measures. These regulations benefit fishermen by allowing the staging of pots near the fishing grounds.

Vessel tank inspections. Vessel tank inspections, addressed in Section 2.1.3, are a Category 3 management measure in the FMP. Under existing State law, these are required to provide for a fair start to the fishery. ADF&G informs industry of dates and locations that these inspections will be conducted prior to each fishing season. Under a status quo alternative, ADF&G would be expected to continue this practice, as it provides better management opportunities and therefore protection of the resource.

Gear modifications. As discussed in Section 2.1.3, another Category 3 management measure that the BOF can amend is gear modifications. Gear modifications have been developed to reduce bycatch of undersized and female crab, and to cause a pot to no longer remain in a fishing condition if lost. Under the status quo alternative, no changes would be expected to this effective resource management tool. Crab resources could be expected to continue to realize positive benefits.

Bycatch. In the Council's problem statement addressing the rationalization of the BSAI crab fisheries, bycatch was singled out as a continuing problem that may result in unaccounted mortality of nontarget crab being released to the water. Under the status quo, the incidental harvest of legal male crab of one species with a harvestable catch limit may be retained while targeting another species. Under current regulations, Tanner crab may be harvested in conjunction with ongoing Bristol Bay red king crab and snow crab fisheries when a harvestable surplus of Tanner crab remains. Harvest is also allowed under an established harvest strategy, 5 AAC 35.08. Eastern Subdistrict Tanner Crab Harvest Strategy. Abundance thresholds for Tanner crab are the determining factor for their harvest in each instance. Bycatch may also include females, as well as undersized, or unmarketable males. Several studies have indicated that deadloss or incidental mortality may increase as a result of excessive handling, especially during cold weather. The actual rate or magnitude of mortality in handled but discarded crabs remains unknown. The harvest strategies for Bering Sea king and Tanner crab stocks were developed by ADF&G to accommodate mortality rates of 20 to 30 percent in captured, discarded crabs. If fisheries were to continue to operate under status quo management, incidental harvest and bycatch mortality rates would continue under the current race for fish.

Highgrading is the taking of those legal male crab considered premium in grade or size. Currently, crab fisheries in the Bering Sea operate in a manner that encourages some level of highgrading. Size and sex restrictions, along with escape ring requirements, cause gear to fish most effectively for larger male crabs. However, additional sorting on deck for clean shelled crabs, resulting in potentially increased mortality in crabs returned to the sea, is a management concern. At this time, given present season lengths, highgrading is not considered a management problem because fishermen pulling up pots with excessive numbers of dirty shell crab will tend to move to new fishing areas in order to avoid the time necessary to sort for marketable crab in a fishery operating under the constraints of a very short season. Therefore, no change to existing stock status would be anticipated under the status quo alternative.

Observer requirements. The State has specific observer requirements for the crab fisheries occurring in the BSAI. Currently, ADF&G requires that C/P vessels have 100 percent observer coverage to fish for BSAI crab. One reason that the BOF placed observers onboard crab C/P was because those vessels were demonstrated to have been retaining sublegal sized crab. ADF&G managers overseeing the day to day management of the crab fishery have a target level for observer coverage on catcher vessels (CVs) of 10 percent. Observers are necessary in obtaining catch, effort, and biological data. If BSAI crab fisheries continue to operate as they have recently, no significant changes to the observer program would be anticipated. ADF&G believes that present observer coverage of the various harvesting sectors provides sufficient data. Similarly, resource benefits would continue to be derived from data collected by observers.

Other management measures. In the other management measures category, some management measures create efficiencies or address penalties in other fisheries in which crab fishermen might also participate, but not at the expense of the crab resources. Generally, there is a 30-day no-fishing period (stand down) for vessels using pot gear in non-crab fisheries prior to (prospecting) or following (enforcement) the crab season in an area. This prohibits prospecting for crab prior to the season, however is not necessary to protect other pot fisheries, such as pot-caught Pacific cod because of the License Limitation Program (LLP) in place. No additional changes or impacts to the crab resource would be anticipated if crab were harvested under status quo management.

Vessels are currently unrestricted from participating in other state or federally managed fisheries, except under provisions of the American Fisheries Act (AFA) and miscellaneous State vessel size restrictions. Spillover in certain crab fisheries has been recognized by the BOF through recent adoption of the AFA Crab

Management Plan, 5 AAC 39.695. Spillover can be contained in federal jurisdiction fisheries through LLP and other means, but in a status quo alternative, some crab fishermen and owners may opt to continue to leave the crab fisheries and find other uses for their vessels.

Alternative 2 Three-pie voluntary cooperative program

The preferred alternative is designed to provide resource conservation, solutions to utilization and management problems, address bycatch and its associated mortalities along with reductions in deadloss, tackle the issues of excess harvesting and processing capacity causing poor economic returns, while solving problems regarding the lack of economic stability for harvesters, processors, and coastal communities. The preferred alternative should provide solutions for creating a safer working environment for participants in an occupation that is continually ranked by the Food and Agricultural Organization (FAO) as the most dangerous in the nation. In a January 2001 press release, the FAO stated that in the United States, the fatality rate among fishermen is 25 to 30 times the national average in other occupations.

To accomplish or address these issues, the preferred alternative may require the BOF to adopt or change a number of regulations. The Council's motion includes an option to request ADF&G and the BOF to address the concerns of discards, highgrading, incidental catch and the need for bycatch reduction and improved in-season monitoring to coincide with implementation of a rationalization program. All of these concerns can be addressed by the BOF under the authority provided in the existing FMP in Categories 2 and 3 management measures. The BOF may choose to change additional management measures at the request of industry or to improve the manageability of the fisheries. ADF&G requests changes to the crab fisheries regulations though the BOF process. It is not possible to predict the exact management measures the BOF will adopt because each measure is adopted through its public process, much like the Council's process. Members of the public can provide recommendations to the BOF on crab management in three ways. The public can submit a proposal to the BOF to make specific changes to the BSAI crab fisheries management measures. The public can submit oral and/or written public testimony to the BOF before they take action on an issue, or members of the public can serve on committees that make recommendations to the BOF. The following actions, while hypothetical, represent reasonable actions the BOF may take to accomplish the goals of this alternative. However, the actions analyzed here in no way reflect any limits to the broad range of proposals that the BOF may choose to address.

Guideline harvest levels. Under rationalization, GHLs will not be practical. With fishermen and processors working under their own IFQ shares, the fisheries will have to be managed by TAC. For most stocks, the TAC would be set based upon the summer survey and the stock's existing harvest strategy. For stocks without good population assessment, harvest history, or a harvest strategy, the TAC would be set conservatively to address uncertainty in stock condition. The harvest strategies for establishing TACs would continue to account for assumed bycatch, highgrading, and handling mortality. The harvest strategies may be adjusted if bycatch increases under the rationalized fishery. Successful manipulation of current harvest strategies or other BOF actions to more accurately reflect current fleet practices would ensure long term reproductive viability and the continued health of the resource.

TAC is generally considered to be the fixed target goal necessary for a quota share system. TAC allows fishermen participating in quota share fisheries the confidence that regardless of when they choose to harvest their shares, their quota amount would not change for the duration of the season. Those opting to fish later should have no concern that the catch ceiling may be reduced, thereby reducing their allocated percentage of the total catch as compared to fishermen who had fished their share early in the season. Since a change from a GHL to a TAC approach would not allow for inseason quota adjustment based on fishery performance, harvest quotas for un-surveyed crab stocks, such as the Aleutian Islands golden king crab, would be set at conservative levels.

Management to the TAC rather than a GHL will ensure better resource conservation at low stock levels, as many GHLs were exceeded because high levels of participation. To ensure that the TAC is not exceeded, ADF&G or NOAA Fisheries will need a catch accounting system to track harvested quota shares. Alternative 2 contains a penalty structure to help ensure vessel operators stay within the TAC. Vessels with overages of 3 percent or less on their last delivery will forfeit that amount to the State. Vessels with overages greater than 3 percent on their last delivery may also face legal actions for the violation.

Inseason adjustments. With quota shares, a fishery will continue to be prosecuted within the biological season until the TAC is reached, or the season ends. Fishermen and processors will determine when their initial start up occurs each season, and will conclude fishing when their individual quotas are taken. Therefore inseason adjustments would no longer be an appropriate management tool.

Seasons. Alternative 2 should provide relief to the short seasons that exist in the status quo fisheries. Proposals are expected to be addressed by the BOF that would permit longer fishing seasons. Protracted seasons will provide a safety factor to these fisheries by allowing fishermen greater leeway to remain in port during severe storms, and protect crab stocks by reducing handling mortality associated with severe weather handling and sorting conditions.

It is anticipated that seasons will be allowed to occur during most of the year outside those biologically sensitive periods when molting, mating, and summer surveys occur. The crab plan team has reevaluated the current biological seasons to include new information on crab mating and molting to more accurately describe biological seasons, and has reviewed the effect of broader fishing seasons with respect to natural mortality during the interval between the survey and the fishery. Because some biological activities, such as molting, may vary with annual regimes, a CDQ or IFQ fisherman who chooses to fish late in the season, close to the edge of a biological period, may encounter softshell crab. Note that the Council's Crab Plan Team changed the biological season from June 1 to May 15 for snow crab because of soft shell crab. Under rationalization, if fishermen did run into soft shell crab (as they have in snow crab) then the State would attempt to adjust open areas through the use of their emergency order authority to target the fleet on areas of marketable crab for fisheries where the stock occur over a broad area (such as snow crab).

In the Bering Sea, fishing for red and blue king crab stocks might be permitted to occur from August to January, although the ultimate season adopted by the BOF would be based on the considerations required by the FMP. Other than the sensitive mating and molting period, the BOF would need to consider product quality, minimization of bycatch, environmental conditions, minimization of deadloss, and the cost to industry operations. Different segments of the industry are likely to have differing views on potential season length; however ADF&G assumes that fishing seasons are likely to expand under rationalization. The magnitude of the expansion cannot be predicted. While sales of crab increase during mini-peaks for specific holiday seasons in the Asian markets (Year end sales/New Year's celebration, Golden Week - April 29 to May 10, and the Obon Festival between July 13-15 or August 13-15, depending on the region), crab, especially the less expensive snow crab, remains a regular part of the Japanese diet. Increased demands for domestic markets continue for snow crab as well. Fisheries could extend for the majority of the year, as long as they avoid the biological season. However it is likely that the actual season set by the BOF would be less than that given analysis of summer survey data, manageability, market conditions, meat fullness, etc.

Fisheries for golden king crab in the western Aleutian Islands, which now extend from mid-August into the late-spring, would probably continue to have lengthy harvest periods because there is no defined biological mating and molting period. The Aleutian Islands golden king crab fishery in the eastern portion of the management area could extend beyond the current 3-4 week seasons recently seen.

Pot limits. Under status quo, gear limitations implemented to minimize problems caused by the race for fish has led to excessive gear on the grounds, gear conflicts, and lost gear. In a rationalized fishery the number of vessels on the grounds at any one time will likely be reduced. If vessel participation decreases through the formation of coops, leasing arrangements, or sale of quota share with exit from the fishery, the BOF may decide to increase the number of pots allowed to be fished by each vessel or even consider rescinding pot limits entirely. However, the BOF may decide that an upper level on pot limits be retained to assure that gear continues to be fished in an orderly and controlled manner. The BSAI king and Tanner crab FMP authorizes ADF&G to use pot limits to attain the biological conservation objective and the economic and social objective of the FMP. In establishing pot limits, the BOF would consider, within constraints of available information, the following:

- total vessel effort relative to GHL;
- probable concentrations of pots by area;
- potential for conflict with other fisheries;
- potential for handling mortality of target or nontarget species;
- adverse effects on vessel safety including hazards to navigation;
- enforceability of pot limits; and
- analysis of effects on industry.

Pot limits must be designed in a nondiscriminatory manner. For example, pot limits that are a function of vessel size can be developed which affect large and small vessels equally. Historic data on pot registration and LOA could be used for developing pot limit regulations.

Changes in gear limits can have both biological and economic implications and serve to protect the resource health as well. As gear limits and seasons are relaxed, actual pot soak times should increase, as the need to pull a pot in a short period of time is no longer necessary. This increase in soak time will allow the crab to sort on-bottom, diminishing the number of undersized crab brought to the surface. As a result of the increase in soak time, and fishing in potentially less severe weather, handling and bycatch mortalities should decrease.

With a prolonged season, fishermen have increased ability to avoid pack ice, and the problems associated with pot loss. It is anticipated that the number of lost pots due to ice interactions would decrease under a rationalized fishery, along with resource impacts due to lost pots. However, the actual quantitative benefit to the resource remains unknown at this time. On the other hand, prolonged seasons may cause crab fishermen to actually increase their gear interactions with groundfish fishermen in the same area. As with the AFA, cooperatives may work to reduce this potential effect. If fewer pots are placed on the grounds because of consolidation, interaction with other fishing gear and ice should decline.

Registration areas. Under the preferred alternative, registration areas will not be an issue. Norton Sound is the only super-exclusive king crab area, and it was excluded from the rationalization program.

Reporting requirements. The BOF may elect to make changes to some current reporting requirements under a rationalized fishery, while opting to continue others. Reporting of crab catches by individual vessel operators has been required from as early as 1941. Current State reporting requirements at 5 AAC 39.130, include: reporting the company or individual that purchased the catch; the full name and signature of the permit holder, the vessel that landed the catch with its Commercial Fisheries Entry Commission license plate number; the type of gear used; the amount of gear (number of pots, pot lifts); the weight and number of crab landed including deadloss; the dates of landing and capture; and the location of capture. Processing companies are required to report this information for each landing purchased, and vessel operators are required to provide information to the processor at the time of sale. All reports (fish tickets) are confidential. Reporting requirements ensure adequate information and efficient management and enforcement. Fish tickets will still be required by ADF&G, but actual tracking of quota share balances will fall to the federal government under the Restricted Access Management Division. The current practice of inseason reporting directly from the vessels on a daily basis would likely not be necessary under a rationalized fishery because each fisherman will have a set individual quota level to harvest, and the race for fish will be eliminated.

Gear placement and removal and gear storage. Current regulations addressing gear placement and removal will probably need to be reviewed by the BOF, and changes made. Current regulations are in place to ensure that prior to the season opening, and once a season closes, fishermen would be allowed to store pots at specific depths or locations if the gear contained no bait or bait containers and had doors secured fully open. The FMP justifies this practice and acknowledges that gear placement and removal lacks biological impacts, potential gear conflicts, the unavailability of loading and unloading facilities and gear storage areas. Under a quota system, fishing seasons may start at any time within the allowed season, and will end when fishermen's quotas are taken. Current regulations created by the BOF regarding gear placement, removal, and storage would have to be reviewed on a fishery-by-fishery basis.

Vessel tank inspections. The requirement for vessel tank inspections is expected to be maintained under a rationalized fishery. During these inspections, ADF&G staff are looking at gear configurations (escape rings, panel design), buoy marking requirements, and pot limits. However, the importance as an enforcement tool for fair start provisions will no longer be necessary, as each vessel will be harvesting toward their own quota share.

Bycatch/incidental harvest/highgrading. With rationalization, the BOF may establish concurrent seasons for multiple species. This would allow fishermen to harvest all legal-sized, male crab brought onboard for which IFQ is held. This could reduce discards of legal-sized male crab of non-target species (incidental harvest) and reduce mortality from handling and discarding of those crabs. However, because of quota allocations and differing TACs, gear will have to be configured for the most conservative bycatch reduction measures at some point during the fishing seasons. The BOF may implement requirements for mandatory offloading once the quota for one species in a multiple species fishery is reached, and then require re-registration for a new gear configuration (like Tanner boards that restrict the tunnel size to exclude the larger king crab). The BOF may also elect to close the area where the species overlap if enforcement issues arise. Another problem the BOF may need to address is one concerning the definition of management areas. Management areas are different for each fishery and the districts do not perfectly overlap. For example, in the Bristol Bay red king crab season, the fishery is located east of 168°W longitude. However, the eastern

Subdistrict for Tanner crab is east of 173°W longitude. ADF&G managers would not want a redistribution of effort resulting in localized depletion in the area of species overlap in a multi-species fishery. Fishery boundaries have been established through a review of historical effort by area. Some species overlap occurs in some areas. If concurrent fisheries are allowed, it is conceivable that fishermen would, for economic reasons, try to capture their entire allocated quota for one species as incidental harvest to their directed fishery in the same area.

Some small level of highgrading has been observed in CDQ crab fisheries which operate in a rationalized manner, but this is not widespread. If highgrading appears to be a problem, the BOF could take action to halt or diminish this practice. The best tool to deal with this would be reevaluation of current harvest strategies. ADF&G harvest strategies set caps on the harvest rate of the size-shell component of legal males that is selected for retention in the fishery.

Other options the BOF may take to address highgrading might include adopting a minimum/maximum mesh size escape panel, ring and tunnel entrance openings to prevent highgrading on the bottom and still allow female and sub-legal crab to escape, time-area closures, increased observer requirements or, less desirable, mandatory retention of all legal animals up to individual or cooperative-pooled quota share limits. Full retention may not be enforceable, and could be counter-productive by lowering long-term fishery value and by increasing deadloss in the tank due to the spread of disease through retention of legal crabs in poor condition.

New regulations will likely need to be developed to protect the biological integrity of the stock. Sorting on the bottom with longer soak times could have similar detrimental consequences if the escape panel mesh size were enlarged above the current regulatory minimum. Only larger crab would be retained (i.e., highgrading). If, however, the mesh size were not allowed to exceed the current size and soak times were to increase (probably adjusting or eliminating pot limits) then sorting on the bottom should prove to be an important conservation benefit of rationalization. Small males and females would escape prior to pot retrieval. Thus, the BOF may consider adopting a minimum/maximum legal size and work with panel, ring and pot mouth openings to achieve these ends.

State observer requirements. A rationalized fleet will still be monitored using onboard observers and dockside samplers. Observer requirements and the program designed to meet those requirements, have been actively in place in selected BSAI fisheries for over 14 years. This program has continued to change and mature. The BOF may elect to make necessary changes to the shellfish observer program. If fleet consolidation occurs and the number of observers deployed remains constant, the percentage of pot lifts and associated catch that are sampled by observers should increase. ADF&G works in conjunction with the Industry Observer Task Force, taking recommendations on levels of observer coverage, cost assessments and payment of those costs. The monitoring program in the fisheries will be adapted to address potential changes in fishing practices under the rationalization program and improve knowledge of stocks in slower paced fisheries by documenting mechanisms for such changes (e.g., to monitor conditions of catch relative to molting/mating periods that may be encountered during protracted seasons, and to monitor any changes in fishery selectivity and on-deck sorting, changes in gear, fishing practices, or areas fished). If problems like highgrading surface, observer coverage may be increased to better document the incidence of occurrence.
In order for the state to meet its statutory responsibility to conserve the resource, Alternative 2 should include funding provisions for sufficient onboard observer and port-sampling coverage. The current CV observer program is limited to an annual budget of $650,000 that is based on cost-recovery fishing. This observer

program covers approximately 10 percent of the CV fleet in current selected fisheries. Observer coverage on vessels processing king or Tanner crab at sea, vessels fishing in special-permit fisheries, and vessels fishing in the Aleutian Islands golden king crab fishery continues to be paid for by vessel operators. This amount of $650,000 with an additional increment, is needed to fully develop and implement the observer program and to evaluate the conservation benefits of rationalization. Deployment of observers in protracted seasons under rationalization may have higher overhead costs (travel, for example) than under the current compressed seasons. Additionally, it may be desirable to have costs of observer deployments shared more equitably across vessels under a rationalization program, as opposed to the current system where some components of the fleet bear the cost of observers and others do not. Similarly, the number of port samplers stationed at shorebased facilities could likely be increased to observe and assess potential changes under rationalization. Extended fishing seasons would necessitate coverage of multiple shore-side delivery locations over an extended period. Overall, resource benefits should be enhanced by better data collection, with real-time reporting to track potential changes, allowing promulgation of adaptive regulations addressing problematic areas.

Alternative 3 Individual fishing quota program

Under any alternative, the management goals under the FMP remain the same; which are to maximize the overall long-term benefit to the nation of BSAI king and Tanner crab stocks by coordinated federal and state management, consistent with responsible stewardship for conservation of the crab resources and their habitats. As is the case with the preferred alternative (three-pie voluntary cooperative), implementation of an IFQ alternative could require changes to management strategies currently operating under the status quo. These changes would have to come about through actions by the BOF, and could involve both FMP Categories 2 and 3 management measures, although Category 3 measures would remain at the discretion of the State.

As an IFQ fishery is similar to the three-pie model in management approach and some management measures would be the same. As was described in the discussion for Alternative 2, Category 2 measures such as minimum size limits, districts, subdistricts and sections, sex restrictions, and registration areas would not change. These are fundamental biological or reporting considerations that operate under an IFQ or non-IFQ fishery. Several Category 2 measures would require board action, however. In consideration of implementation of an IFQ program in the BSAI king and Tanner crab fisheries, subsequent changes in the historical characteristics of these fisheries could require changes in several management measures.

Guideline harvest levels. As with the preferred alternative, any IFQ fishery cannot be prosecuted under existing GHLs. Under IFQ shares, the fisheries will have to be managed with a TAC. For most stocks, the TAC would be set based upon the summer survey and the particular stock harvest strategy, and not changed. For stocks without good population assessment, harvest history, or a harvest strategy, the TAC would be set conservatively to address uncertainty in stock condition. TAC is generally considered to be the fixed target goal necessary for a quota share system. TAC allows fishermen participating in quota share fisheries the confidence that regardless of when they choose to harvest their shares, their quota amount would not change for the duration of the season. Those opting to fish later should have no concern that the catch ceiling may be reduced, thereby reducing their allocated percentage of the total catch as compared to a fisherman who had fished their share early in the season. Since a change from a GHL to a TAC approach would not allow for inseason quota adjustment based on fishery performance, harvest quotas for un-surveyed crab stocks, such as the Aleutian Islands golden king crab, would be set at conservative levels.

Management to the TAC under IFQs rather than a GHL under status quo fisheries will ensure better resource conservation at low stock levels, as many GHLs were exceeded because high levels of participation.

With any quota share based fishery, it will continue to be prosecuted within the biological season until the TAC is reached, or the season ends. Fishermen, in discussions with individual processors, will determine when their initial start-up occurs each season, and will conclude fishing when quotas are reached. Therefore inseason adjustments, a Category 2 management measure, would no longer be an appropriate management tool. To ensure that the TAC is not exceeded, ADF&G or NOAA Fisheries will need a catch accounting system to track harvested quota shares. The Council adopted a penalty structure to help ensure vessel operators stay within the TAC. Vessels with overages of 3 percent or less on their last delivery will forfeit that amount to the State. Vessels with overages greater than 3 percent on their last delivery may also face legal actions for the violation.

Seasons: Rationalization, in any of the IFQ-based alternative forms, should provide relief to several problems that exist in fisheries operating under the status quo. Proposals are expected to be addressed by the BOF that would permit longer fishing seasons. It is anticipated that seasons will be allowed to occur during most of the year outside those biologically sensitive periods when molting, mating and summer surveys occur. The crab plan team has reevaluated the current biological seasons to include new information on crab mating and molting to more accurately describe biological seasons, and has reviewed the effect of broader fishing seasons with respect to natural mortality during the interval between the survey and the fishery. Because some biological activities, such as molting, may vary with annual regimes, a CDQ or IFQ fisherman who chose to fish late in the season, close to the edge of a biological period, may encounter softshell crab. Note that the Council's Crab Plan Team changed the biological season from June 1 to May 15 for opilio because of soft shell crab. Under rationalization, if fishermen did run into soft shell crab (as they have in *C. opilio*) then the state would attempt to adjust open areas through the use of their emergency order authority to target the fleet on areas of marketable crab for fisheries where the stock occur over a broad area (such as *C. opilio*).

In an IFQ crab fishery prosecuted in the Bering Sea, fishing for red and blue king crab stocks might also be permitted to occur during most of the year outside those biologically sensitive periods. The ultimate season adopted by the BOF would be based upon a number of considerations addressed in the FMP. Other than the sensitive mating and molting period, the BOF would need to consider product quality, minimization of bycatch, environmental conditions, minimization of deadloss, and the cost to industry operations. Different segments of the industry are likely to have differing views on potential season length; however the ADF&G assumes that fishing seasons are likely to expand under rationalization. The magnitude of the expansion cannot be predicted.

Pot limits. Another action that would almost certainly occur through BOF actions would be changes to existing pot limits imposed in these crab fisheries. A race to fish can lead to excessive gear on the grounds, gear conflicts, and lost gear. To minimize these problems, limits on gear have been implemented. In an IFQ fishery, it is anticipated that vessel participation will diminish through consolidation of fishing effort. If vessel participation decreases through the formation of coops, leasing arrangements, or sale of quota share with exit from the fishery, the BOF may decide to increase the number of pots allowed to be fished by each vessel or even consider rescinding pot limits entirely. However, the BOF may decide that some upper level on pot limits needs to be retained to assure that gear continues to be fished in an orderly and controlled manner. The BSAI king and Tanner Crab FMP authorizes the ADF&G to use pot limits to attain the biological conservation objective and the economic and social objective of the FMP. As with the consideration of the preferred alternative, changes in gear limits can have both biological and economic implications that serve to protect the resource health as well. As gear limits and seasons are relaxed, actual pot soak times should increase, as the need to pull a pot in a short period of time is no longer necessary. This increase in soak time will allow the gear to sort on-bottom, diminishing the number of undersized crab brought to the surface. As a result of the increase in soak time, and fishing in potentially less severe weather, handling and bycatch mortalities should decrease.

With a prolonged season, fishermen have increased ability to avoid pack ice, and the problems associated with pot loss. It is anticipated that the number of lost pots due to ice interactions would decrease under an IFQ fishery, along with resource impacts due to lost pots. However, the actual quantitative benefit to the resource remains unknown at this time. On the other hand, prolonged seasons may cause crab fishermen to actually increase their gear interactions with groundfish fishermen in the same area. However, if fewer pots are placed on the grounds because of consolidation, interaction with other fishing gear and ice should decline.

Reporting requirements. Under Category 3 measures, it is anticipated that reporting requirements would have to be addressed by the BOF if an IFQ program was implemented. The BOF may elect to make changes to some current reporting requirements, while opting to continue others. Fish tickets will still be required by the ADF&G, but actual tracking of quota share balances will fall to the federal government under NOAA Fisheries. ADF&G will coordinate with NOAA Fisheries to get timely data. The current practice of inseason reporting directly from the vessels on a daily basis would likely not be necessary under a rationalized fishery because each fisherman will have a set individual quota level to harvest, the race for fish will be eliminated, and it is anticipated that overages would be subject to penalties. These would likely deter overages.

Gear placement and removal. Current regulations addressing gear placement and removal, another Category 3 measure, will probably need to be reviewed by the BOF. Current regulations are in place to ensure that prior to the season opening, and once a season closes, fishermen would be allowed to store pots at specific depths or locations if the gear contained no bait or bait containers and had doors secured fully open. Under any quota system, fishermen's seasons may start at any time within the allowed season, and will end when their quota is taken. To improve management and efficiency, the BOF may elect to implement changes. Regardless, current regulations created by the BOF regarding gear placement, removal, and storage would have to be reviewed on a fishery by fishery basis. The BOF will also consider other gear interactions when addressing this issue.

Pot storage. Crab pots are generally stored on land or in designated storage areas at sea. As with gear placement and removal, under this rationalization approach, the BOF may elect to modify current regulations for reasons similar to those explained for Alternative 2.

Gear modifications. Gear Modifications presently include the use of escape mechanisms on all crab pots. While this would likely not change under an IFQ voluntary cooperative fishery, the BOF may adopt regulations addressing minimum/maximum mesh size escape panel and/or ring and tunnel entrance openings to prevent highgrading on the bottom and still allow female and sub-legal crab to escape.

Vessel tank inspection. Category 3 measures like vessel tank inspections might be expected to be changed, although not significantly. Boats operating under a quota program may choose to begin participation in a fishery at any time within an established, protracted season, based upon logistical or market considerations. Prior to that first effort, the ADF&G may still require vessel tank and gear inspections to track effort and meet other legal requirements. However, their importance as an enforcement tool for fair start provisions will no longer be necessary, as each vessel will be harvesting toward their own quota share.

Measures to reduce bycatch, incidental harvest, and highgrading. Under a fishery that operated on an IFQ framework, new regulations will likely need to be developed to protect the biological integrity of the stock. As described for the preferred alternative, similar considerations would also apply for an IFQ approach. These could develop as a result of continued monitoring of bycatch to judge the effectiveness of this approach to rationalization. It is widely accepted that increased soak time should reduce bycatch of sublegal crab, however fishing characteristics of the fleet could change. Changes in area fished, soak time, pot limits, market characteristics, and stock distribution could all affect bycatch rates. Gear modifications to allow escapement, such as escape rings or large mesh panels, will be evaluated under longer soak times and changes in fishery/processor selectivity and fishing strategies. As long as concerns over highgrading, or ghost fishing from lost pots (if pot limits are removed), do not evolve then rationalization should have environmental-friendly impacts on our crab resources and their associated habitat. Sorting on the bottom with longer soak times could have similar detrimental consequences if the escape panel mesh size were enlarged above the current regulatory minimum. Only larger crab would be retained, i.e., highgrading. If, however, the mesh size were not allowed to exceed the current size and soak times were to increase (through adjustment or elimination of pot limits) then sorting on the bottom should prove to be an important conservation benefit of rationalization. Small males and females would escape prior to pot retrieval. Thus, managers may consider adopting a minimum/maximum legal mesh size and work with panel, ring and pot mouth openings to achieve these goals. Additionally, if concurrent seasons are adopted, the BOF may wish to allow gear modification to allow retention of more than one species of crab, while still protecting escape of sub-legal and female crab.

The state may implement incidental harvest limits of crab in crab fisheries managed under the FMP. Retention of non-target species may be allowed in concurrent seasons if the population of bycatch species is sufficient (above threshold minimums). As previously mentioned, harvest strategies developed for Bering Sea king and Tanner crab stocks since the mid-199Bering Sea account for assumed incidental harvest and handling mortality of non-retained crabs in the determination of the harvest rate on mature- or legal-sized males. Presently, Tanner crab are harvested incidentally in both the Bristol Bay red king and snow crab seasons.

Changes in area fished, soak time, pot limits, market characteristics, and stock distribution could all affect bycatch rates. Extended soak times and gear modifications should allow for sorting to occur while the pots are still on bottom. This should drastically reduce handling of non-retained animals, and the subsequent, associated handling mortality. Under the IFQ alternative, fishermen may be able to avoid fishing during severe weather conditions that may be detrimental to bycaught crab and may have the time and economic incentive to search for areas with the highest value crabs and lowest bycatch.

Observers. In an IFQ fishery, vessels would be engaged in fishing over a longer part of the year, complicating oversight of fishing. To adequately monitor the fishery, changes in observer coverage might be required by the BOF. Managers are concerned about the enforcement implications of a relatively slower paced and/or longer duration fishery. Under any rationalization program that increases the season length, the state believes that crab C/P vessels will need to have enough observer coverage to enforce sex and size limits for crab. One reason that the BOF placed observers onboard crab C/Ps was because those vessels were demonstrated to have been retaining sublegal sized crab. Additionally, the State believes management of C/P crab vessels should include special unloading requirements to limit the ability of C/Ps to exceed their quota without detection.

Increased season length will also have effects on the CV observer program. The current CV observer program is limited to an annual budget of $650,000 that is based on cost-recovery fishing. This covers approximately 10 percent of the CV fleet in selected fisheries. Observer coverage on vessels processing king or Tanner crab at sea, vessels fishing in special-permit fisheries and vessels fishing in the Aleutian Islands golden king crab fishery continue to be paid for by vessel operators. Changing fishing seasons through rationalization will necessitate continued collection of at-sea data to assess the effects of protracted seasons and soak times on bycatch and other fishery effects. These data could also help assure enforcement of harvest regulations. Observers will be necessary to document distribution of effort, catch, and bycatch, to monitor condition of catch relative to molting/mating periods that may be encountered during protracted seasons, and to monitor any changes in fishery selectivity and sorting. Funding for ADF&G to replace existing cost-recovery funds is necessary. This amount, and an additional increment, is needed to fully develop and implement the observer program and to evaluate the conservation benefits of rationalization. Deployment of observers in protracted seasons under rationalization may have higher overhead costs (for travel, for example) than under the current compressed seasons. Additionally, it may be desirable to have costs of observer deployments shared more equitably across vessels under a rationalization program, as opposed to the current system where some components of the fleet bear the cost of observers and others do not.

State government is not limited to only the management measures described in the FMP. Implementation of other management measures not described in the FMP must be consistent with the FMP, the Magnuson-Stevens Act, and other applicable federal laws, and may occur only after consultation with the Council. Other management measures the State may implement are subject to the review and appeals procedures described in the FMP.

Alternative 4 Cooperative

The State believes that any actions deemed necessary by the BOF for a cooperative program with a closed class of processors would mirror those for a fishery operating under an IFQ program. Both are prosecuted as IFQ fisheries, and potential State decisions under the Category 2 and 3 management measures would therefore be similar, if not identical.

4.1.2 Projected fleet composition and fishing practices

This section examines fleet composition and fishing practices under the alternatives. Fleet composition and fishing practices are dependent on the management and biological conditions in a fishery. The current biological conditions in the fisheries are described in Chapter 3. The alternative management programs under consideration are described in Chapter 2. An understanding of the current fishing practices, which are described in Chapter 3, is also useful to project potential practices under future management.

Quantitative information that assist in the understanding of the differences of the alternatives are presented. These data are information such as the number of persons that would receive harvest privileges and the limitations on holdings and use of those harvest privilege under the alternatives. These data provide only a partial understanding of the fleet composition and harvest practices under the different alternatives because they do not predict whether individuals might choose to transfer or use their privileges. The transfer and use of privileges by individuals will depend on several factors, including biological and economic factors and the management program created by the alternative. Because of the difficulty projecting fluctuations in crab stocks and harvest levels in the BSAI crab fisheries, no projections of specific numbers of vessels in the different fisheries are made. Instead the historical fisheries are used as the basis to develop an understanding of future fisheries under the different alternatives. Fluctuation in stock sizes and harvest levels are one impediment to projecting fleet size under the alternatives. In addition, accurate projection of fleet sizes would require extensive and detailed economic information concerning the fleet. Revenue and cost data needed for this analysis are not available at this time. In addition, the novelty of some of the programs under consideration complicate the projection of practices of participants under the alternatives. The processors protections and regional and community protection components of the different rationalization programs could limit the ability of harvesters to consolidate harvesting on vessels, since these aspects of the alternatives are likely to influence the geographic distribution of landings.

Harvester participation, fleet composition, and impacts on captains and crew under the status quo alternative

In the current LLP fisheries, harvester participation is limited by LLP licenses. Since a license embodies only a privilege to participate in a fishery, a license does not represent any share of the harvests from a fishery, but only an opportunity to participate in the race for fish. Consequently, the benefits of a license depend on the harvester's performance in the competitive fishery. Licenses authorize fishing in one or more fisheries (depending on the fishing that gave rise to the license). Licenses may be used on any vessel in the class designated by the license, however, a license holder must designate the vessel on which a license will be used prior to fishing.[1] Licenses are transferable, but privileges to enter different fisheries supported by a single license cannot be separated. Many licenses are owned by corporations or partnerships. Notwithstanding the ability to transfer licenses among vessels, most license holders own (or at least own an interest in) the vessel operating under the license and oversee the use of the license. In the most recent years, several licenses in each crab fishery have not been used.

[1] Licenses are for a designated vessel length class (less than 60 feet, 60 feet to 125 feet, or over 125 feet), a maximum length overall (MLOA), and carry a CV or C/P designation.

Vessel participation and fleet composition in the status quo alternative

Table 4.1-1 shows the number of licenses (interim and permanent) in the current fisheries, as well as the number of participants in the seasons between 1995 and 2000. The table shows that several license holders have not participated in the most recent years in each of the fisheries proposed for rationalization. Current depressed stocks and GHLs are likely a contributor to the number of inactive licenses. Conflicting seasons with other crab and ground fisheries could also contribute to license holders choosing not to participate. Under continuation of the current LLP management at current harvest levels, the number of participants is likely to remain at its current level or decline. Some of the current participants may have remained in the fishery in anticipation of allocation of shares under a rationalization program (such as the other alternatives currently under consideration). Anticipating that shares in such a program would be allocated based on historical harvests, some participants in recent years might have instead chosen not to participate. If the current management is continued with no expectation of future share allocation based on historical harvests, it is possible that some license holders might not participate in the fisheries in future years. If stocks recover and harvest levels increase substantially in the future, latent licenses could be used, increasing the number of participants in the fisheries from those observed in recent years. The likelihood of these stock increases and the number of entrants they might induce cannot be predicted because of data unavailability. Another factor that could affect the number of participants is the adjudication of interim licenses. Since several interim licenses are pending adjudication, the outcome of those adjudications could impose a limit on the total number of participants in future fisheries. The outcomes of these adjudications could limit the expansion of the fleet, but are unlikely to force any reduction in the number of participants since the number of latent licenses currently exceeds the number of interim licenses.

Table 4.1-1 License Limitation Program licenses and participation levels in recent seasons of the Bering Sea and Aleutian Islands crab fisheries.

		WAI (Adak) Brown King Crab	EAI (Dutch Harbor) Brown King Crab	Aleutian Islands Red King Crab	Bering Sea Opilio	Bering Sea Bairdi	Bristol Bay Red King Crab	Pribilof Red and Blue King Crab	St. Matthew Blue King Crab
Licenses	Permanent	27	27	26	254	254	250	110	165
	Interim	11	11	12	55	55	52	26	34
	Total	38	38	38	309	309	302	136	199
Participating vessels in season beginning in	2000	12	15	closed	228	closed	244	closed	closed
	1999	15	15	closed	241	closed	256	closed	closed
	1998	3	14	closed	229	closed	274	57	131
	1997	9	13	closed	226	closed	256	53	117
	1996	13	14	closed	234	196	194	66	122
	1995	18	18	closed	closed	196	closed	119	90

Source: RAM Division, February 20, 2002 and NMFMC Crab Rationalization Database 2001, Version 1.

Notes: EAI - Eastern Aleutian Islands
WAI - Western Aleutian Islands

In the current LLP fisheries, LLP licenses are designated as either CV or C/P. C/P licenses are issued to those vessels that processed crab during the equilibrium vessel participation (EQP), the qualifying periods during which a harvester must have landings to receive an LLP license for an area/species endorsement. All harvests caught by a vessel licensed as a C/P may be processed on board. The absence of an allocation to the sector implies that the share of a fishery that is harvested by the C/P sector depends on the performance of the sector in the competitive fishery. Table 4.1-2 shows the number of CV licenses and the number of C/P licenses by area/species endorsement. Since license endorsements apply to multiple fisheries, the headings in this table differ from those of Table 4.1-1, which shows participation levels in the different fisheries. The table shows that C/P are a relatively small part of the BSAI crab fleet, with outstanding C/P licenses being less than one-fourth of all licenses in the Aleutian Islands fisheries and less than one-tenth of all licenses in the other fisheries. Although C/P participation has declined with stocks in recent years, the relative share of the fleet made up by C/P has generally remained constant in recent years. Based on this trend, C/P might be expected to remain a relatively small part of the fishery under continuation of the current management.

Table 4.1-2 Number of License Limitation Program licenses by vessel type and species/area endorsement.

		Aleutian Islands Brown King Crab	Aleutian Islands Red King Crab	Bering Sea and Aleutian Islands Opilio and Bairdi	Bristol Bay Red King Crab	Pribilof Red and Blue King Crab	St. Matthew Blue King Crab
Catcher/processor	Permanent	6	4	20	19	2	12
	Interim	3	1	7	7	1	2
	Total	9	5	27	26	3	14
Catcher vessel	Permanent	21	22	234	231	108	153
	Interim	8	11	48	45	25	32
	Total	29	33	282	276	133	185
Total	Permanent	27	26	254	250	110	165
	Interim	11	12	55	52	26	34
	Total	38	38	309	302	136	199

Source: RAM Division, February 20, 2002.

Fishing practices under the status quo alternative

In the current fisheries, harvesters are forced to compete for a share of the total harvest in a race for fish. As a result, the current practice of harvesters fishing around the clock during relatively short seasons can be expected to continue. Pot limits, together with the pressure to haul gear in short intervals, contribute to relatively short soak times that give gear escape mechanisms little time to sort crab increasing bycatch. The need to compete for harvests reduces the incentive to search for lost pots. If not recovered, a pot can continue to "ghost fish" until the lashing on the escape mechanism decomposes. Ghost fishing of lost pots may result in unobserved crab mortality. The time pressure of the race for fish also increases the incentive for harvesters to fish through extreme weather. In addition, under the pressures of the current competitive fishery, harvesters have little time to search for stocks of legal crab. Harvesters risk losing catch, if they move from areas with reasonable harvest rates of legal males, to avoid high bycatch of undersized and female crab.

Projected impacts on captains and crew participation[2]

In the current LLP fisheries, most captains and crew have no direct ownership interest in the fishery (in the form of limited licenses or vessels). Instead most captains and crew are employed by vessel owners that participate in the fisheries. Levels of participation of captains and crew are determined primarily by vessel participation levels. Most CVs have a crew of approximately 5 or 6 persons, including the captain. These crew levels are likely to continue, if the current management is maintained in the fishery. The total number of crew employed in the fishery, however, is likely to change with the number of vessels in the fishery.

[2] This section is limited to an analysis of operational aspects of the fishery. Discussion of the economic impacts of the alternatives on captains and crew is contained in Section 4.6.

Working conditions faced by crews in the crab fisheries are known to be among the most dangerous in the U.S. The fishing grounds in the BSAI are known for their extreme weather and dangerous seas. The race for fish under the current management contributes to the dangers. Captains and crew work long hours, often around the clock, doing physically demanding work in hazardous conditions. Most captains and crew are rewarded with a share of the total harvest revenues, so each has an incentive to work to increase a vessel's total harvests. These incentives can tempt both captains and crew to take unreasonable risks.

The low stock levels and excess capacity in the current fisheries have also had a detrimental effect on employment and wages of captains and crew. When stocks were higher, positions working in the crab fleet were very rewarding. With low stocks, captains and crew are able to fish a few weeks of the year limiting their ability to make a reasonable living off the fisheries. Many captains and crew work in several of the crab fisheries and supplement their income by participating in other fisheries or working in other jobs.

Harvester participation under the rationalization alternatives

Harvester participation under the three rationalization alternatives is determined by share allocations and rules related to the use and transfer of those shares. These provisions overlap substantially under the three rationalization alternatives (the three-pie voluntary cooperative alternative, the IFQ alternative, and the cooperative alternative). To allow for better contrast of these three alternatives and to avoid repetition, the discussion of fleet composition and fishing practices under the three rationalization alternatives is consolidated into a single section. Differences in the different rationalization programs that could affect the fleet composition and participation are identified.[3]

Harvest share allocations

Harvest participation under the rationalization alternatives is dependent, in part, on the distribution of shares under those different programs. In the three-pie voluntary cooperative alternative (and the two other rationalization alternatives), harvesters would be allocated harvest shares (quota share [QS] in the three-pie voluntary cooperative alternative and the IFQ alternative or cooperative shares in the cooperative alternative) in each fishery rationalized by the program. In all of the programs, harvest shares are a revocable privilege that allow the holder to receive an annual allocation of a specific portion of the annual TAC from a fishery. Harvest share allocations are based on historic participation in the fisheries to preserve existing distribution of interests in the fishery and the value of capital investments. Eligibility requirements and qualifying years are the same under the different rationalization alternatives, so the allocation of harvest shares are identical under the different rationalization alternatives. In all of the fisheries, the allocations rely on several years of participation, so the number of harvesters receiving an allocation in each fishery is generally greater than the average number of vessels participating in recent years despite the declines in participation in some fisheries.

To receive a harvest share allocation in a fishery a harvester must hold a valid, permanent, fully transferable LLP license endorsed for the fishery. Generally, qualified catch is the catch of the vessel that created the privilege to the LLP license on which eligibility is based. Since LLP licenses (and permits under the vessel moratorium program that preceded the LLP) are transferrable from vessel to vessel, catch on the vessel on

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[3] The analysis in this section is limited to fleet size, participation levels, and fishing practices. The distribution of benefits under the different alternatives are likely to differ. The analysis of that distribution of benefits is presented later in Section 4.

which a license was used would be included in determining the allocation associated with a license. Because the use of license on a vessel was not recorded during the first two years of the LLP, the number of persons that harvested crab with an LLP license on two vessels is not known with any certainty. The consistency of participation in the fishery, however, suggests that few participants moved licenses between vessels. An additional provision would permit a person that purchased a LLP license to continue to participate in a fishery to receive an allocation based on the history of the vessel on which the license was used. Less than 12 participants would qualify for this provision. Finally, a provision would permit persons that owned vessels that sank and were replaced under the LLP license qualification rules to credit 50 percent of their average annual history in qualifying years that the vessel participated, for years that the vessel or its replacement was unable to participate. Less than ten participants would qualify for this provision. In general, provisions for crediting qualifying catch from a vessel other than the vessel that created the LLP privilege are intended to reward participation in compliance with the LLP or limit the hardships that arise from circumstances outside of a participant's control.

The initial allocation of shares varies from fishery to fishery because of different levels of participation and participation patterns. Figures 4.1-1, 4.1-2, and 4.1-3 show the estimated initial allocation in the different fisheries. Eligibility and distributions were estimated on a vessel basis. Since some participants may own interests in multiple vessels and licenses, the estimates may not be totally accurate. Confidentiality of vessel and license ownership information prevent more detailed disclosure of the allocations.[4]

[4] The data collection program included in the preferred rationalization program would require participants to submit ownership information from which individual interests in the fisheries could be analyzed.

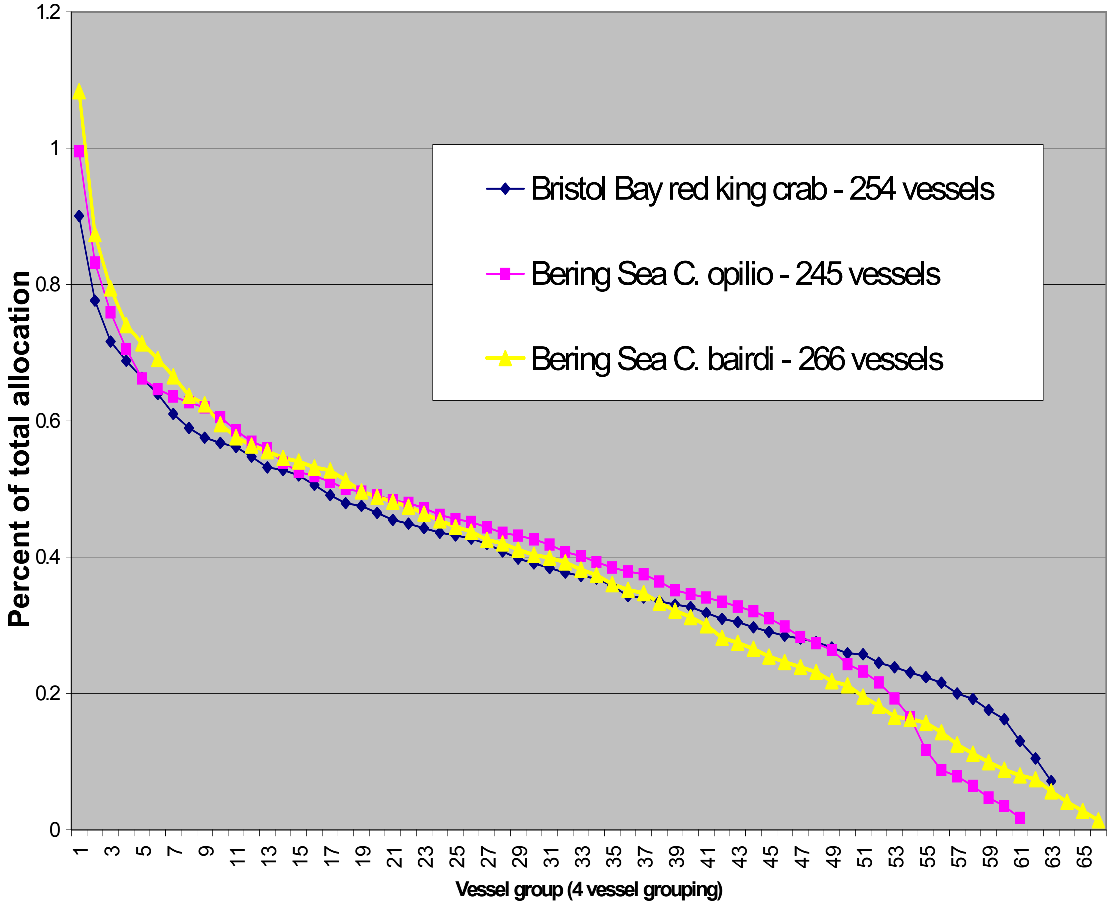

Figure 4.1-1 Harvest share allocation for Bristol Bay red king crab and Bering Sea *C. opilio* and *C. bairdi* crab fishery.

Source: NPFMC Crab Rationalization Database 2001, Version 1

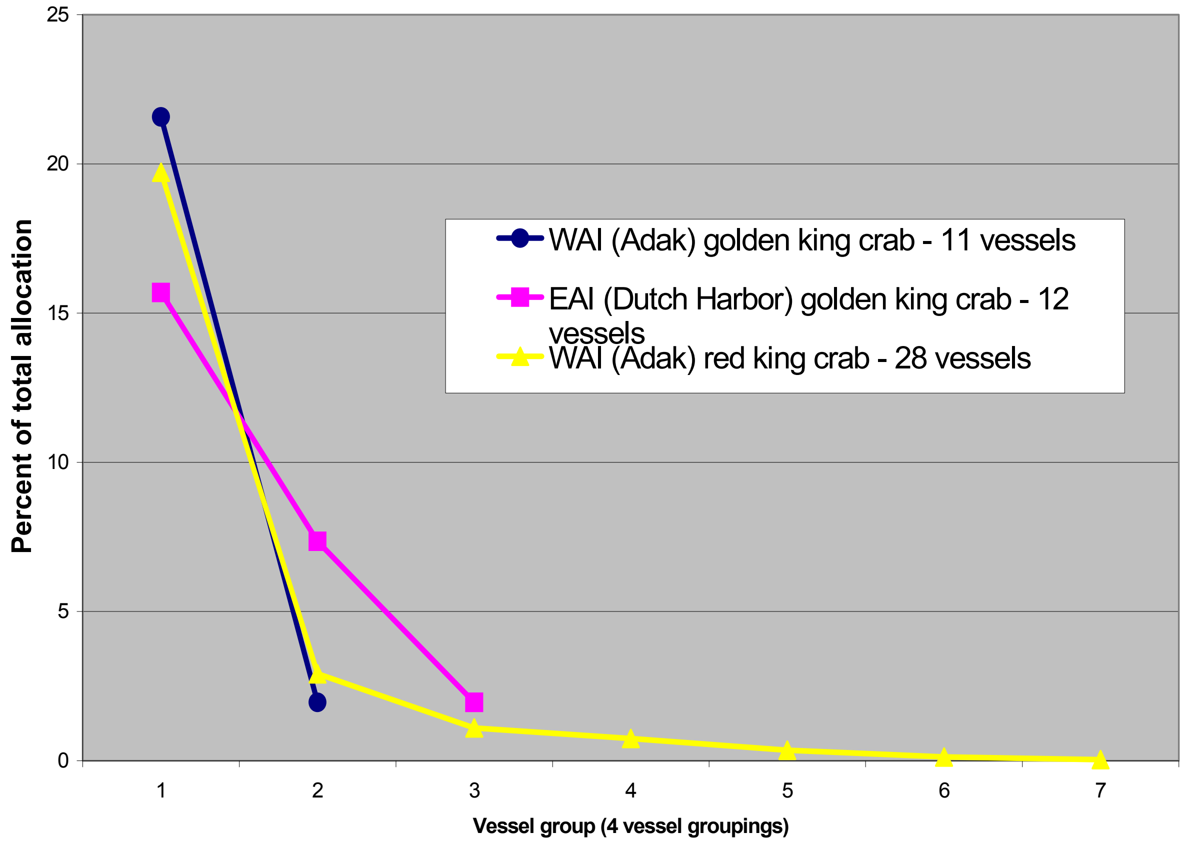

Figure 4.1-2 Harvest share allocation for western Aleutian Island golden and red king crab, and eastern Aleutian Island golden king crab fishery.

Source: NPFMC Crab Rationalization Database 2001, Version 1

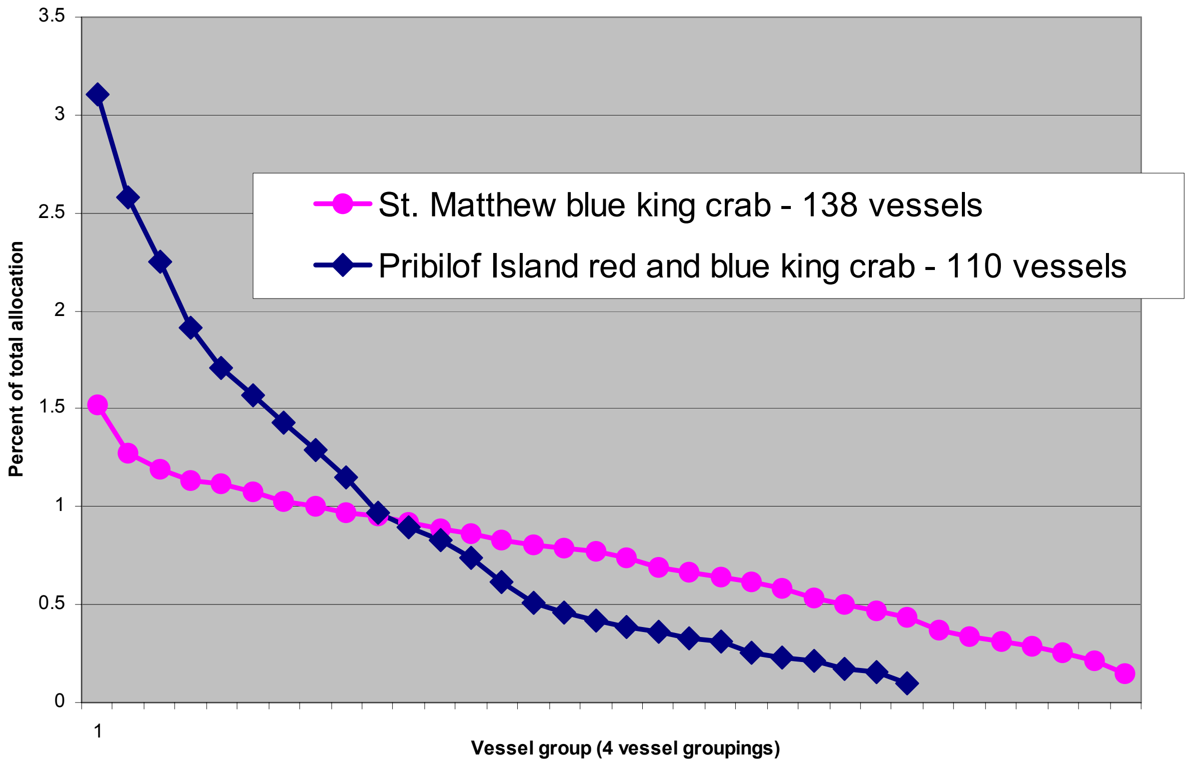

Figure 4.1-3 Harvest share allocation for St. Matthew blue king crab and Pribilof Island red and blue king crab fishery.

Source: NPFMC Crab Rationalization Database 2001, Version 1

To protect confidentiality, the allocations are shown in groups of four vessels, with vessel groupings made in descending order from the largest estimated allocation to the smallest allocation. The last and smallest grouping contains between four and seven estimated allocations, since at least four persons' activities must be included under confidentiality rules. The estimated allocation shown for each four vessel group is the average allocation to members of that group. Allocations are shown as shares of the total harvest allocation. Each legend shows the total number of vessels that would receive an allocation in each fishery. Because allocations are averages, it is possible, particularly in the grouping with the largest allocation, that the largest allocation to a single vessel is significantly different from the average of those four vessels.

The figures show that the allocations vary significantly from fishery to fishery. Differences in the allocations arise from the different patterns of participation and catch history in the different fisheries. The Bering Sea *C. opilio* and *C. bairdi* and the Bristol Bay red king crab fisheries have the greatest estimated number of eligible vessels (between 245 and 266) and the least concentrated distribution. In these fisheries, the average of the largest four allocations is approximately 1 percent of the total allocation. The median allocation is approximately 0.4 percent of the total allocation. The allocation in the St. Matthew blue king crab fishery is slightly more concentrated, with 138 vessels estimated to receive an allocation. The average of the largest four allocations in these fisheries would be approximately 1.5 percent of the total allocation. The median allocation would be approximately 0.8 percent. In the Pribilof red and blue king crab fishery 110 vessels are estimated to receive an allocation. The average of the four largest allocations is estimated to be approximately 3 percent. The mean allocation in this fishery is approximately 0.6 percent (slightly less than the median allocation in the St. Matthew blue king crab fishery). The allocations in the Aleutian Islands fisheries are the most concentrated. These fisheries are the most distant from processing and other support facilities, discouraging some participation. The golden king crab fisheries also require additional gear for longlining pots and have limited grounds, complicating entry to those fisheries. Approximately 30 vessels would receive an allocation in the Western Aleutian Islands (Adak) red king crab fishery, which has been closed for several years, but is showing signs of recovery. The four largest allocations in this fishery are estimated to average almost 20 percent of the total allocation. The concentration of shares in the fishery is also shown by the low median allocation, which is less than 1 percent. In the two Aleutian Island golden king crab fisheries, slightly more than ten vessels would receive an allocation. The Western fishery, however, is more concentrated than the Eastern fishery. In the Western fishery, the four largest allocations are estimated to average approximately 22 percent of the total allocation. The median allocation in the fishery is estimated to be approximately 2.6 percent. In the Eastern fishery, the four largest allocations average approximately 16 percent, while the median allocation is slightly less than 8 percent.

Harvest share use and transferability and limits on holdings

Harvest shares under the rationalization alternatives represent a privilege to harvest a portion of the TAC of a fishery. The privileges created by shares and their use, however, differ under the different rationalization alternatives. In the IFQ alternative, the annual allocation of harvest shares would be made to and could be used by the harvester holding those shares. In the cooperative program, a harvester's annual allocation would be made to the harvester's cooperative and would be used in accordance with the rules of the cooperative. If a harvester is not a cooperative member, the annual allocation would be forfeited. In the three-pie voluntary cooperative alternative, if a harvester is a member of a cooperative, the annual allocation would be made to the cooperative for use in accordance with its rules. If the harvester is not a cooperative member, the allocation would be to the harvester who would determine the use of the shares.

Under each of the rationalization alternatives, harvest shares would be transferrable, subject to limits on the amount of shares a person may hold or use.[5] To purchase shares a person would need to have at least 150 days sea time in a commercial fishery in a harvest capacity. Corporations and partnerships could purchase shares if a 20 percent owner meets the sea time requirements. Initial recipients of shares and qualified CDQ and community groups are exempt from these eligibility criteria. These sea time requirements are intended to ensure that the harvest sector does not evolve into a fishery owned by entities that have no fishing background. Liberal transfer rights in all three of the rationalization alternatives, however, could result in some share holders having little or no direct activity in the fisheries, instead choosing to lease their shares to more active share holders that manage fishing operations or own and operate vessels. The number of persons holding a harvest privilege in the fisheries that do not maintain an ownership interest in vessels or undertake an active role in a fishing operation is likely to increase under the any of the three rationalization alternatives. The extent of this increase cannot be predicted.

Under the three rationalization alternatives, separate caps would be imposed on the share holdings of any person,[6] intended to prevent excessive consolidation of shares. Limits on share holdings can be used to increase market competition, facilitate entry to the fishery, protect labor markets, and ensure that the resource supports several participants. Separate, higher caps are applicable to the six CDQ groups. Since CDQ groups represent several persons, higher share holding caps are thought to be justified. The caps on shareholdings

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[5] In the three-pie voluntary cooperative, a possible limitation on leasing may apply to persons not in cooperatives after the first five years.

[6] The Council clarified its position on ownership and use caps at its October 2002 meeting. Since limits on ownership effectively control the use of shares, ownership caps can be interpreted as capping use. This parallels the interpretation of use caps as limiting ownership adopted in the halibut and sablefish IFQ program.

proposed for the different fisheries and the number of owners and vessels in excess of those caps at the time of the initial allocation are shown in Table 4.1-3. The accuracy of these data, however, is limited by the lack of availability of complete ownership data. The analysis relied on registered license holder data files, which do not show ownership holdings beyond the registered owner. Detailed ownership data necessary for full analysis of ownership are currently unavailable. Application of the rules under the program will require the submission of detailed ownership information by shareholders.

Limits on share holdings alone, do not determine the minimum number of vessels in a fishery, since liberal leasing rules would permit several share holders to fish their shares on a single vessel. Vessel use caps, on the other hand, could prevent the consolidation of use of the shares of several share holders on a single vessel. The three-pie voluntary cooperative alternative and the IFQ alternative both contain limitations on the use of harvest shares on a single vessel, which are shown in Table 4.1-3. No vessel use caps are provided in the cooperative alternative. The application of the vessel use caps differ under the three-pie voluntary cooperative alternative and the IFQ alternative, so the outcome of those limitations is likely to differ. The use caps would apply to all vessels in the IFQ alternative. Consequently, those caps establish the minimum number of vessels in each fishery under the IFQ alternative. In the three-pie voluntary cooperative alternative, vessels harvesting shares of cooperatives are not subject to the vessel use cap. If a substantial portion of share holders enter cooperatives, vessel use caps are unlikely to increase the number of vessels participating in the fisheries.

Table 4.1-3 Number of allocations to persons and vessels and ownership and use caps for the BSAI crab fisheries.

	Number of owners[1]	Ownership cap	Number of owners over the cap	CDQ ownership cap	Number of vessels[2]	Vessel use cap	Number of vessels over the cap
Western Aleutian Islands (Adak) Golden King Crab	14	0.10	*	0.20	11	0.20	*
Western Aleutian Islands (Adak) Red King Crab	38	0.10	6	0.20	28	0.20	*
Bristol Bay Red King Crab	303	0.01	10	0.05	254	0.02	0
Bering Sea C. Opilio	290	0.01	16	0.05	245	0.02	0
Bering Sea C. Bairdi (EBS Tanner Crab)	312	0.01	17	0.05	266	0.02	0
Eastern Aleutian Islands (Dutch Harbor) Golden King Crab	15	0.10	6	0.20	12	0.20	*
Pribilof Red and Blue King Crab	136	0.02	18	0.10	110	0.04	0
St. Matthew Blue King Crab	163	0.02	*	0.10	138	0.04	0

Sources: NPFMC Crab Rationalization Database, Version 1, 2001 and NMFS, RAM license registration files (2001).

1. Allocations to vessels are aggregated based on LLP license ownership files of NMFS RAM.

2. Allocations are on a vessel basis without aggregation.

Under the IFQ program, whether the vessel use caps would ever increase the number of vessels in any fishery cannot be predicted. The discussion of the vessel participation levels under all of the rationalization alternatives provides a discussion of the factors that influence vessel participation that is likely to determine the degree to which the caps are binding. In considering those factors and their relation to the vessel use cap, one must bear in mind that the decision to enter a vessel in the fishery is made by an individual or group of individuals and not the fleet as a whole. As a consequence, the vessel use cap could bind some participants (requiring that they operate more vessels than they would have without the cap), while not affecting other participants who would choose to operate under the cap, in the absence of the cap.

To protect independent vessel owners and processors that are not vertically integrated, processor ownership of harvest shares will also be limited by caps on vertical integration. Table 4.1-4 shows the number of processors with affiliated vessels, the number of vessels affiliated with processors, and allocations to those vessels.[7] A vessel and processor with 10 percent common ownership are considered affiliated, as required by the threshold rule in the preferred alternative. Vertical integration varies by fishery. The three Aleutian Islands fisheries have a single processor affiliated with a single participating vessel. In the Pribilof and St. Matthews fisheries, four processors are affiliated with nine and ten vessels. These processor affiliated vessels will receive between 8 and 12 percent of the total allocation. In the Bristol Bay and Bering Sea fisheries, six processors are affiliated with between 25 and 35 vessels. These vessels will receive slightly more than 12 percent of the total allocation in these fisheries. Confidentiality restrictions prevent the disclosure of the number of allocations over specific levels.

[7] The analysis of vertical integration relied on ownership data provided to the analysts by major processors that participate in the BSAI crab fisheries. These data were voluntarily submitted to assist Council staff with the analysis and were fully disclosed during the Council proceedings.

Table 4.1-4 Number of processor/vessel affiliations by fishery.

Fishery	Number of processors affiliated with vessels	Number of vessels affiliated with processors	Number of vertically integrated allocations over 2.5%	Number of vertically integrated allocations over 5%	Total allocation to processor affiliated vessels
Western Aleutian Islands (Adak) Golden King Crab	1	1	0	0	*
Western Aleutian Islands (Adak) Red King Crab	1	1	0	0	*
Bristol Bay Red King Crab	6	31	*	*	0.125
Bering Sea C. Opilio	6	25	*	0	0.122
Bering Sea C. Bairdi (EBS Tanner Crab)	6	33	*	*	0.127
Eastern Aleutian Islands (Dutch Harbor) Golden King Crab	1	1	*	0	*
Pribilof Red and Blue King Crab	4	9	*	*	0.117
St. Matthew Blue King Crab	4	10	*	0	0.086

* Withheld for confidentiality.
Sources: NPFMC Crab Rationalization Database, Version 1, 2001 and processor vessel ownership information (2001).

The concern for vertical integration relates primarily to the distribution of benefits in the fisheries. Participants may integrate vertically to realize efficiencies of that integration. While efficiencies may be realized across sectors through contracting, vertical integration may aid efficiency by avoiding transaction costs. Since the limits on vertical integration are focused on share holdings (rather than vessel participation or vessel use) these caps may have little effect on consolidation in the fleet or fleet composition.

Catcher/processor Interests

Under the three rationalization alternatives, a harvester that is qualified for a harvest allocation that also processed any of its harvests on board during the 1998 or 1999 season would be allocated C/P shares for the portion of its catch that is also processed on board. C/P shares would be issued only for the portion of the catch that was processed on board, while CV shares would be allocated for any qualified harvests that were not processed on board.

Table 4.1-5 describes the allocation of C/P shares in each of the fisheries proposed for rationalization. In the three largest fisheries, the Bristol Bay red king crab, the Bering Sea *C. opilio*, and the Bering Sea *C. bairdi*, nine or ten vessels would qualify for a catcher processor allocation. The total allocation in each of these fisheries ranges from slightly more than 4 percent of the total harvest allocation to approximately 7.5 percent of the total harvest allocation. In the St. Matthew blue king crab fishery the five vessels that qualify for a C/P allocation would receive slightly less than 2 percent of the total harvest allocation as C/P shares. In the western Aleutian Islands (Adak) red king crab fishery two vessels qualify for allocations of catcher processor shares. In the two Aleutian Island golden king crab fisheries and the Pribilof fishery a single vessel qualifies for a C/P share allocation. Allocations in fisheries in which less than four vessels receive an allocation cannot be revealed because of confidentiality restrictions.

Table 4.1-5 Catcher/processor initial allocations.

Fishery	Eligible catcher/ processors	Mean allocation	Median allocation	Total allocation to catcher/ processors
Western Aleutian Islands (Adak) Golden King Crab	1	*	*	*
Western Aleutian Islands (Adak) Red King Crab	2	*	*	*
Bristol Bay Red King Crab	9	0.005	0.004	0.042
Bering Sea C. Opilio	10	0.007	0.008	0.075
Bering Sea C. Bairdi (EBS Tanner Crab)	10	0.006	0.005	0.059
Eastern Aleutian Islands (Dutch Harbor) Golden King Crab	1	*	*	*
Pribilof Red and Blue King Crab	1	*	*	*
St. Matthew Blue King Crab	5	0.004	0.003	0.018

Source: NPFMC Crab Rationalization Database, Version 1, 2001

Under all of the rationalization alternatives, the C/P sector is limited to the initial allocation. The C/P sector, however, could contract if holders of these shares elected to use their shares as CV shares. In the three-pie voluntary cooperative alternative C/P share holders can separate the harvest privilege from the processing privilege. If the two privileges are separated, a Class A harvest share and a corresponding processor share would be created. Once separated the privileges could not be reunited into a C/P share. Holders of C/P shares would also have the option of delivering harvests to other processors for processing without dividing the shares. Under IFQ alternative the holders of C/P shares could either process C/P share harvests on board or deliver those harvests to another processor. Under the cooperative alternative, a C/P cooperative could either process crab on board vessels harvesting its shares or deliver the harvests to another processor. Under any of the rationalization alternatives, the C/P sector is likely to retain its historic participation relative to the CV fleet.

Vessel participation levels and fleet composition under the rationalization alternatives

The number and size of vessels in each fishery under the different rationalization alternatives is likely to depend on several factors. Aspects of the various rationalization alternatives will have different effects on the response of the fleet to the circumstances that might arise in the fisheries. As a consequence, not only is it not possible to determine the magnitude of the participation levels under the different alternatives, but a relative ranking of vessel participation levels under the different alternatives cannot be provided with certainty.

The alternatives can have two different effects on fleet size, both of which must be assessed to understand fleet composition differences under the different alternatives. First, the number of vessels that participants use in the fishery, once all harvest shares transfers are made, is one factor that must be assessed. In other words, the ultimate vessel participation should be assessed given the conditions in the fishery at any point in time.[8] The second effect that must be assessed is how the responses to changes in the fisheries that stimulate changes in vessel participation differ under the different alternatives. These differences in these transitions are an important part of assessing the different impacts of the alternatives on fleet composition, particularly in fisheries in which stock sizes and harvests can make rapid and unexpected changes.

Under all of the rationalization alternatives, changes to in-season management (such as extending seasons and relaxation of pot limits) are likely to facilitate the consolidation of shares on fewer vessels than currently

[8] This is akin to determining the equilibrium vessel participation.

participate in the fisheries. Consolidation levels, however, could differ under the different alternatives as a result of differences in program elements in the different alternatives. Under the three-pie voluntary cooperative alternative, the fleet is likely to consolidate the least. Processing shares, regional landing requirements, and community protections are all likely to contribute to a broader geographical distribution of landings that requires the use of additional vessels. These requirements could also affect the types of vessels used in the fisheries. For example, the "cooling off" period and right of first refusal create community linkages between processing shares and communities that have at least 3 percent of the allocation in any fishery included in the rationalization program. Since the linkages apply in all fisheries (including those in which a community has less than 3 percent of the qualified history) these requirements could result in relatively small amounts of crab being landed in relatively remote location. This distribution could affect the composition of the fleet, if the efficiency of different vessel sizes depends on amount of harvests. The regional landing requirements of the IFQ alternative can be expected to have a similar, but weaker, affect on consolidation.

At the outset, the cooperative structures of the three-pie voluntary cooperative alternative and the cooperative alternative may contribute to more rapid consolidation. The cooperative alternative could result in the more rapid consolidation of harvests on vessels at the cooperative level since cooperation is mandatory under that program. The ease of consolidation is likely to be limited to intra-cooperative consolidation since transfers between cooperatives would be subject to penalties if not approved by the associated processor. The three-pie voluntary cooperative alternative is more amenable to trading among cooperatives, however, the individual processing quota (IPQ) landing requirements could complicate efforts to consolidate. Although the IFQ alternative contains no similar structure that facilitates consolidation, the absence of processor based landing requirements are likely to result in faster and more complete consolidation by the fleet than either of the other two alternatives. The ability of the fleet to consolidate in response to changes in the sizes of allocations is also likely to differ as a result of these differences.[9] The processor landing requirements together with the complications of inter-cooperative transfers under the cooperative structures could hinder harvesters' ability to consolidate under the cooperative structures.

Under the cooperative alternative, an additional complication to consolidation is the multi-species nature of cooperative eligibility. Harvester assignment to cooperatives is dependent on harvest landings the year before implementation. If harvesters choices do not lend themselves to consolidation across fisheries the ability to consolidate within a cooperative could be limited. Many harvesters participate in several fisheries. Each will bring its harvests from all of its fisheries to its cooperative. So, cooperative members might have compatible histories that can be efficiently consolidated in one or two fisheries but each may also participate in a different, third fishery. Consolidation in those other fisheries may be complicated by the multi-species cooperative structure in the program. Trading of shares with other cooperatives, which could take additional time, may be required.

Consolidation under three-pie voluntary cooperative alternative could be similarly complicated. The flexibility of that structure, which allows participants to be members of more than one cooperative, would allow an additional avenue for consolidation that is unavailable in the cooperative alternative. Processor shares, however, could make consolidation more difficult since harvesters are limited in their ability to coordinate deliveries by these landing requirements.

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[9] The value of the fishery suggest that harvesters are unlikely to leave crab unharvested, so fleets are likely to be able to expand in response to increase abundance.

Fleet composition under the different rationalization alternatives is likely to be similar but is very difficult to predict. A core group of specialized crab vessels is likely to dominate the fisheries. The majority of these vessels are likely to operate in several of the crab fisheries. Some vessels may specialize in a single or few crab fisheries, particularly in the golden king crab fisheries, where pots are longlined. In addition to specialized crab vessels, a group of vessels is likely to be used in crab fisheries that also participate in groundfish fisheries. Many of these vessels are likely to be exclusively pot boats allowing for low cost transitions between the fisheries. Vessels that transition between pot gear and other gear types could also be used in the crab fisheries, particularly in years when TACs are high and additional effort is necessary to harvest the quota. Some of these vessels may transition from other gear types if TACs rise sharply or harvest efficiencies can be realized on particular vessels. In years of high TACs, vessels with large capacity, such as trawl vessels that can be converted to pots may be used to increase effort in the fisheries. Other vessels may be used for special efficiencies. For example, if an individual or cooperative has a relatively small allocation to fish in a particular fishery, a relatively small longline vessel may be converted to a pot configuration, if it is able to harvest the allocation more efficiently than larger crab vessels that might need to be removed from a larger fishery. The specific composition of the fleet will be determined by efficiencies such as these and the consolidation of shares by harvesters, which is likely to depend in part on individual relationships and preferences which are not known or predictable.

The corporate nature of the fleet could contribute to consolidation under any of the alternatives. Compared to some other fisheries, the crab fisheries have few owner-operators. An owner-operator might be reluctant to consolidate activities on a vessel with other participants since working on board could bring both financial and other compensation. For a share holder that is not actively involved in the operation of the vessel, lifestyle considerations are less likely to influence the decision of whether to fish shares with other participants. The preference for maintaining an involvement in the industry, however, could keep some participants active who might otherwise sell their shares. Again, these different influences cannot be gauged.

Fishing practices under the rationalization alternatives

Fishing practices are likely to be similar under all of the rationalization alternatives, as the factors likely to influence harvesters' fishing practices are similar under the rationalization alternatives (Table 4.1-6). The most important impact on fishing practices arises from the allocation of fixed shares in the fisheries and extension of seasons that are likely to disperse fishing activity temporally. These effects are likely to be strongest in the Bristol Bay red king crab and the Bering Sea *C. opilio* fisheries where seasons have been as short as a few days or weeks in recent years. The removal of the time pressure of the race to fish should have a noticeable effect on the behavior of harvesters on the grounds. The allocation of shares will reduce the incentive for harvesters to fish through severe weather to avoid a loss of catch.

The fixed allocation and the season extensions under the preferred alternative should also allow harvesters to respond to specific market demands. In some cases, these demands could result in temporal dispersion of harvest activity. If specific customers demand specific products at specific times or a more general demand for specialized fresh product develops, such as live crab, these demands could result in some dispersion of harvest activity. The dispersion of fishing over time is likely to be mitigated by the interest in harvesting crab with optimum meat fill, (which is seasonally dependent) and harvesters responses to known periods of high demand. High demand can result from either holidays and festivals. Timing of fishing and excess demand can also be affected by competition from fisheries in other areas of the world. So, harvest activity may disperse temporally, but will still concentrate to the extent that harvesters perceive an economic benefit to concentration of harvests. The exact outcome of these factors cannot be known and could change year-to-year with stock fluctuations and market conditions.

As noted above, extending fishing over a longer period of time will also allow harvesters to reduce harvest capacity in the fishery. The relaxation of pot limits is also likely to contribute to capacity reductions. Allowing a vessel to use more pots and fish a fixed allocation should together result in longer soak times, as time pressures are removed and harvesters with more pots to tend can schedule pot lifts at larger intervals without leaving crews inactive. The longer soak times should allow escape mechanisms on the gear more time to sort crab, resulting in less harvest of undersized and female crab, reducing bycatch. The removal of time pressures on harvesters by fixed harvest allocations and longer seasons should also reduce the amount of lost gear, since harvesters will not sacrifice harvests, if extra time is taken to search for lost pots. Lost pots contribute to crab mortality since they will continue to fish until the twine on the escape mechanism decomposes.[10] The fixed harvest allocations could decrease bycatch in the fisheries by allowing harvesters time to change locations without loss of catch. Harvesters that retrieve pots with relatively high quantities of undersized or female crab or low value dirty shell crab are more likely to move to other areas in search of higher value catch, if their total harvest is secure through the fixed allocation.

Although the removal of the time pressure of the race for fish could reduce some detrimental fishing practices, it could also increase the propensity of harvesters to high grade, discarding lower quality crab to catch higher valued crab. Harvesters will have an incentive to high grade if the price difference between high quality crab and low quality crab exceeds the costs of discarding the low value crab and harvesting high valued crab. Whether an incentive to high grade exists will depend on harvest costs and price differences, which cannot be predicted at this time. Monitoring and regulation can be used to assess the level of high- grading and establish rules that will limit its effects on stocks. The use of monitoring and regulation to manage high grading is discussed later in this section. Issuance of fixed harvest allocations that extend several years into the future are argued by some to reduce the incentive for detrimental high grading. This effect would arise if harvest share holders believe that wasteful fishing practices reduce future allowable catch. If fishers do not believe that their individual harvest practices have a substantial effect on future crab stocks, they might try to maximize their current income, perhaps at the expense of future stocks. The outcome of these competing effects cannot be predicted.

Projected impacts of the rationalization alternatives on captains and crew participation

Captain and crew participation are likely to be similarly impacted by the different rationalization alternatives. Consequently, the analysis of impacts on captain and crew participation under the different alternatives is consolidated in this section.[11] A few specific provisions in all of the rationalization alternatives are intended to address captains and crew. These provisions are discussed briefly, after which more general effects of the alternative on captain and crew participation are considered (Table 4.1-6).

[10] The tendency of lost gear to continue to fish is commonly known as ghost fishing.

[11] This section focuses exclusively on participation. Discussion of the economic impacts of the alternatives on captains and crew is contained in Section 4.6.3.7.

C Share allocations and share holdings of captains and crew

Under the three rationalization alternatives, eligible captains will receive an allocation of 3 percent of the TAC in each fishery. These allocations to captains are referred to as C shares. Eligibility and the distribution of these allocations are the same under the three rationalization alternatives (Table 4.1-6). In all of the programs, C shares are a revocable privilege that allow the holder to receive an annual allocation of a specific portion of the annual TAC from a fishery. The starting point for examining the impacts of C shares is to examine the initial allocation of those shares. The impacts of the allocation alone reveal only part of the impact since shares will be tradeable and are subject to rules limiting their use and transfer. The impact of the alternatives and the C shares on captains and crew are discussed after discussion of both the initial allocations and the rules governing transfer and use of the shares.

C share allocations are based on historic participation in the fisheries as a means to protect the historic interests of captains. Eligibility requirements and qualifying years are the same under the different rationalization alternatives, so the allocation of harvest shares are also identical. To receive a C share allocation in a fishery a captain must meet both a qualifying year landing requirement and a recency landing requirement. In fisheries closed in recent years, the recency requirement requires that the captain have landings in one of the fisheries that has been open in recent years. In all of the fisheries, the allocations rely on several years of participation.

Figures 4.1-4, 4.1-5 and 4.1-6 show the estimated initial allocation of C shares in the different fisheries. To protect confidentiality, the allocations are shown in groups of four captains, with captain groupings made in descending order from the largest estimated allocation to the smallest allocation. The last and smallest grouping contains between four and seven estimated C share allocations, since at least four persons' activities must be included under confidentiality rules. The estimated allocation shown for each four vessel group is the average allocation to members of that group. Allocations are shown as shares of the total C share allocation. Each legend shows the total number of captains that would receive an allocation in each fishery. Because allocations are averages, it is possible, particularly in the grouping with the largest allocation, that the largest allocation to a single captain is significantly different from the average of those four captains.

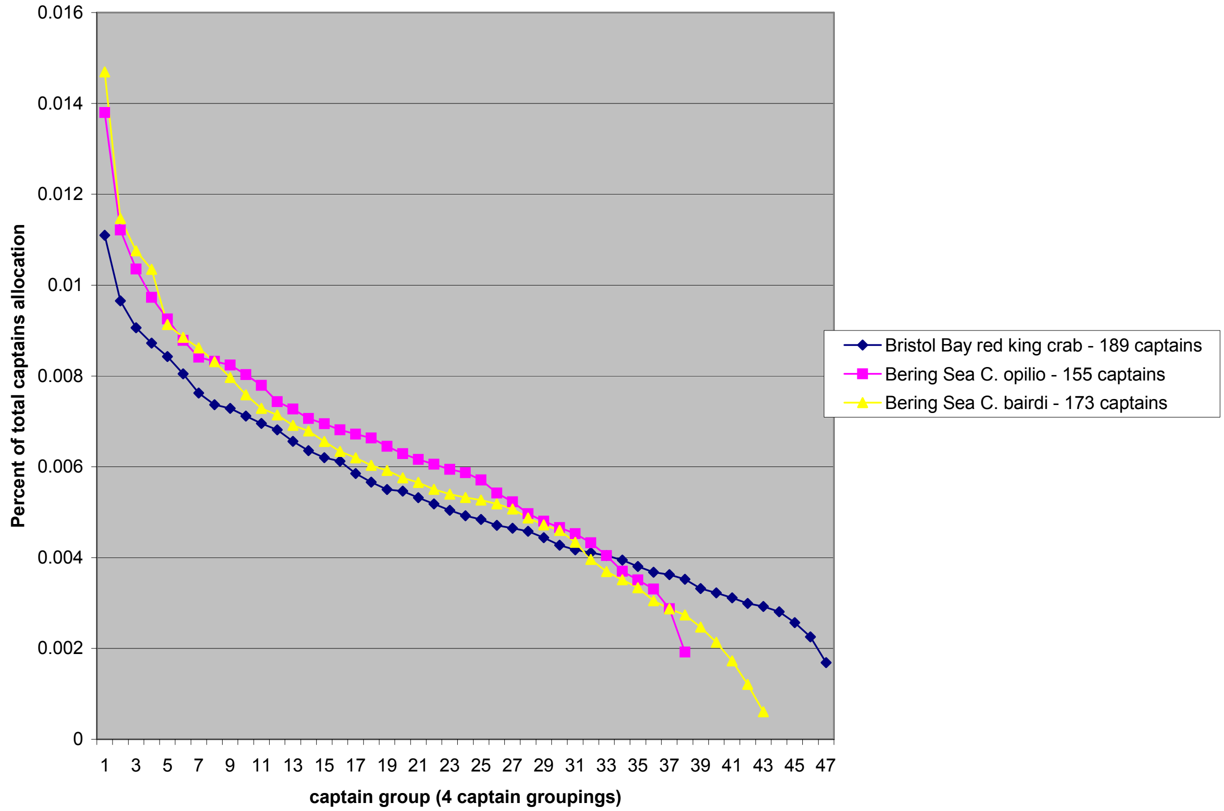

Figure 4.1-4 Estimated C share allocation for Bristol Bay red king crab and Bering Sea *C. opilio* and *C. bairdi* crab fishery.

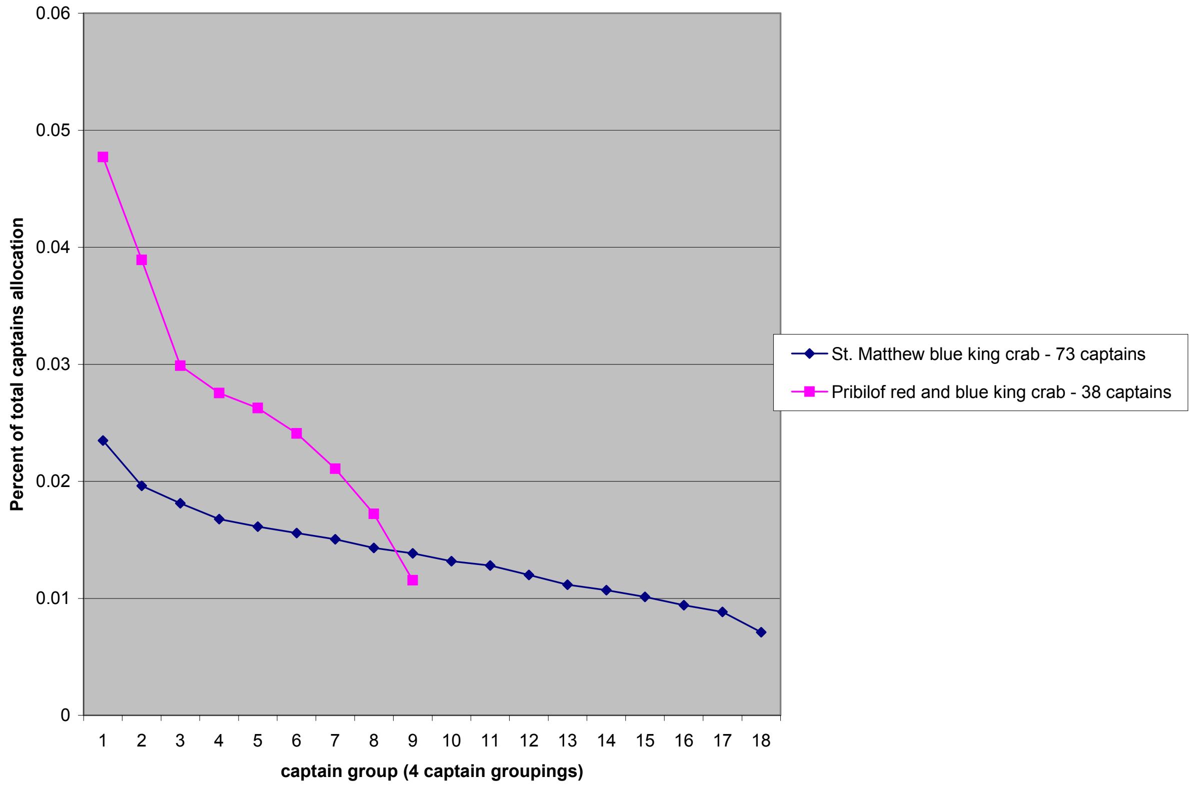

Figure 4.1-5 Estimated C Share allocation for St. Matthew blue king crab and Pribilof Island red and blue king crab fishery.

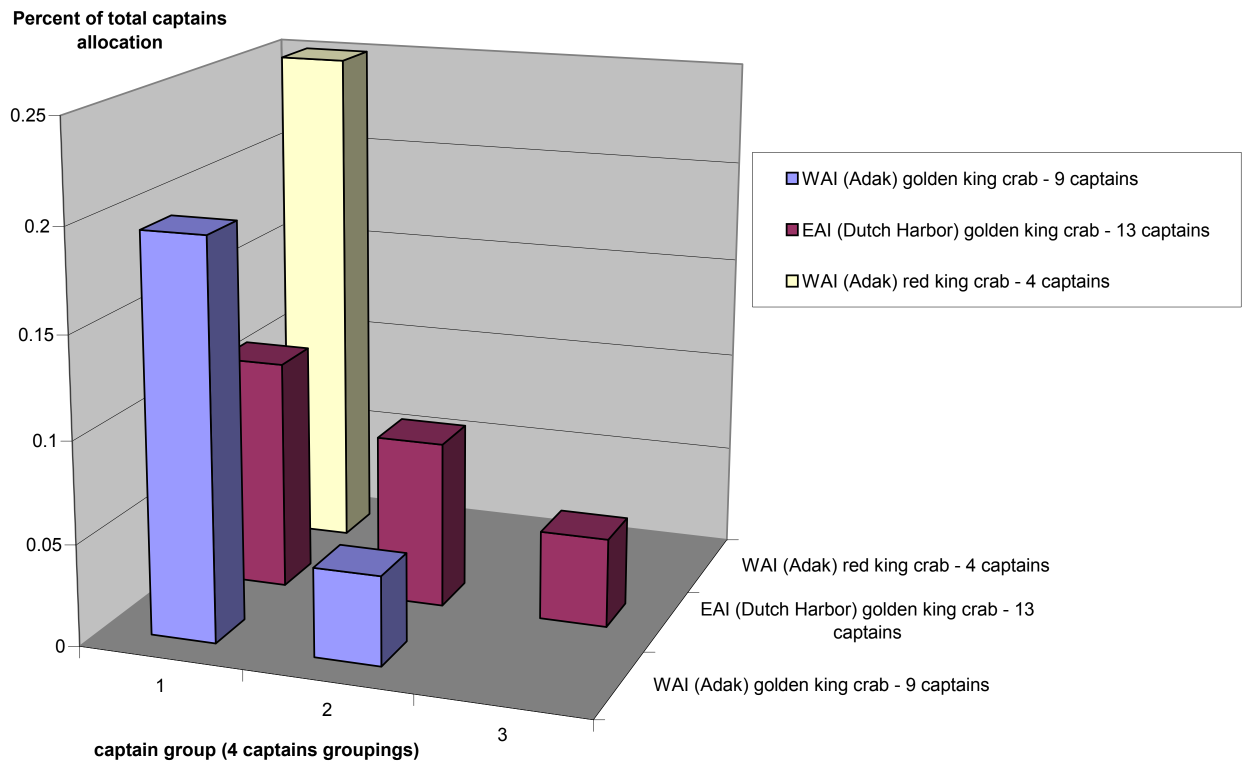

Figure 4.1-6 Estimated C Share allocation for western Aleutian Island golden and red king crab, and eastern Aleutian Island golden king crab fishery.

The figures show that the allocations vary significantly from fishery to fishery. Differences in the allocations arise from the different patterns of participation and catch history in the different fisheries. The Bering Sea *C. opilio* and *C. bairdi* and the Bristol Bay red king crab fisheries have the greatest estimated number of eligible captains (between 155 and 189) and the least concentrated distribution. In these fisheries, the average of the largest four allocations is between 1 percent and 1.5 percent of the total C share allocation. The median allocation is approximately 0.5 percent of the total C share allocation. The allocation in the St. Matthew blue king crab fishery is slightly more concentrated, with 73 captains estimated to receive an allocation. The average of the largest four allocations in this fishery would be approximately 2.3 percent of the total C share allocation. The median allocation would be approximately 1.3 percent. In the Pribilof red and blue king crab fishery 38 captains are estimated to receive a C share allocation. The average of the four largest allocations is estimated to be approximately 4.8 percent of the total C share allocation. The mean and median allocation in this fishery is approximately 2.6 percent. The allocations in the Aleutian Islands fisheries are the most concentrated. These fisheries have the least vessel participation and consequently the least captain participation. Approximately four captains would receive an allocation in the western Aleutian Islands (Adak) red king crab fishery, which has been closed in several recent years but is showing signs of recovery. Confidentiality protections prevent the release of any data concerning these allocations. In the western Aleutian Islands golden king crab nine captains are estimated to receive an allocation, while 13 captains are estimated to receive an allocation in the eastern Aleutian Islands golden king crab fishery. In the western fishery, the four largest allocations are estimated to average approximately 20 percent of the total allocation. The median allocation in the fishery is estimated to be approximately 6.3 percent. In the eastern fishery, the four largest allocations average approximately 11 percent, while the median allocation is slightly more than 8 percent.

The C share program is similar under the three different rationalization alternatives. Each alternative contains several requirements and limitations that are intended to ensure that C shares are fished by the captains and crews that hold those shares. The primary differences in the treatment of C share under the three rationalization alternatives relate to the links of those shares to processors. In the three-pie voluntary cooperative alternative, C shares could be subject to processor share landing requirements after the first three years of the program. In the IFQ program, no processor share landing requirements are imposed on any harvest shares (including C shares). In the cooperative alternative, C shares holders would be required to be a member of a cooperative and C shares would be subject to the requirement that 90 percent of a cooperative's catch be delivered to the associated processor. Movement among cooperatives would be permitted without the permission or share forfeiture that applies to general harvest shares.

The small allocation together with design features of the C share program (including the owner-on-board requirements and caps on C share holdings) will limit the affects of the C share allocations on vessel participation patterns and fishing practices. Small C share holdings may be expected to be fished on many different vessels. The primary effects of C shares will be their impact on negotiating strength of captains and crew holding those shares, as holders of these shares are most likely to be employed in the fisheries and may have slightly greater negotiating leverage than captains and crew that do not hold C shares.

All three of the rationalization programs also contain a provision for a crew loan program that would fund the purchase of harvest shares (including C shares) by captains and crew. This program is intended to be an independent source of funding for share purchases by captains and crew who might otherwise need to borrow from the vessel owners that employ them to develop an ownership interest in the fisheries. The effectiveness of this program in providing an entry opportunity for captains and crew cannot be predicted with certainty. Any increase in share holdings by captains and crew attributable to the loan program is unlikely to affect fishing practices. Any additional share holdings by captains and crew, however, should add to negotiating strength of captains and crew in the fisheries.

The most dramatic effects of the rationalization alternatives on captains and crew will occur because of the reduction in the number of vessels and the slowing of the pace of fishing. Any fleet consolidation will reduce the number of captains and crew active in the fisheries. The concentration of harvests on the vessels remaining in the fisheries, however, could provide more stable employment to captains and crew that are able to retain positions in the fisheries. Jobs should be for longer seasons since fishing should take place over a longer period of time. The skills of average captain and crew in the fisheries could be expected to increase since only the best of the current participants should be expected to remain in the fisheries and those that remain in the fisheries will spend more time crab fishing perfecting their skills and knowledge of prosecution of the fisheries. Different skills could become more important in the future as harvest participants are likely to benefit from cost efficient harvest of crab, rather than the rapid harvest of crab that benefits participants in a race for fish.[12]

Although participation in the fisheries can be expected to remain dangerous, the slowing of the race for fish should reduce the incentive to take risks that threaten the safety of captains and crew. Captains and crew should be less likely to work around the clock or in bad conditions. Crew sizes might decrease very slightly but a crew of at least five persons, including the captain, is likely to be employed on most vessels, as that is perceived to be the minimum needed to operate a crab vessel.

[12] The affects of the alternatives on compensation of captains and crew are discussed later in Chapter 4.

Table 4.1-6 Harvester participation levels, captains and crew, and fishing practices under each alternative.

	Status quo	Three-pie voluntary cooperative	IFQ	Cooperative
Harvester participation level	Current participation level is maintained or declines slightly; financially stressed participants most likely to exit.	1) Temporal dispersion of fishing will facilitate removal of vessels from the fishery. 2) Landing requirements of processing shares, regionalization, and distribution of landings from community protections limit consolidation. 3) Cooperative structure facilitates rapid intra-cooperative consolidation, but may inhibit inter-cooperative consolidation.	1) Temporal dispersion of fishing will facilitate removal of vessels from the fishery. 2) Absence of cooperative structure could slow consolidation since market for shares must develop.	1) Temporal dispersion of fishing will facilitate removal of vessels from the fishery. 2) Requirement that a cooperative land catch with its associated processor could limit consolidation. 3) Cooperative structure facilitates rapid intra-cooperative consolidation, but may inhibit inter-cooperative consolidation.
Captains and crew	Current participation pattern is maintained.	1) Decline in number of captains and crew with number of vessels. 2) Possible slight decline in number of crew with slowing of race for fish. 3) Improvement in skill of average captain and crew with longer seasons. 4) Reduced incentive for risk taking with end of the race for fish.	1) Decline in number of captains and crew with number of vessels. 2) Possible slight decline in number of crew with slowing of race for fish. 3) Improvement in skill of average captain and crew with longer seasons. 4) Reduced incentive for risk taking with end of the race for fish.	1) Decline in number of captains and crew with number of vessels. 2) Possible slight decline in number of crew with slowing of race for fish. 3) Improvement in skill of average captain and crew with longer seasons. 4) Reduced incentive for risk taking with end of the race for fish.

Table 4.1-6 (Cont.) Harvester participation levels, captains and crew, and fishing practices under each alternative.

	Status quo	Three-pie voluntary cooperative	IFQ	Cooperative
Fishing practices	1) Incentive to race for fish to preserve harvest share.	1) No incentive to race for harvest share, harvest decisions are driven by revenue and cost impacts. 2) Removes incentive to compromise safety to preserve harvest share. 3) Longer soak times could reduce bycatch. 4) Could reduce number of lost pots, reducing mortality from ghost fishing. 5) Potential for increased high grading that can be minimized by monitoring and regulation.	1) No incentive to race for harvest share, harvest decisions are driven by revenue and cost impacts. 2) Removes incentive to compromise safety to preserve harvest share. 3) Longer soak times could reduce bycatch. 4) Could reduce number of lost pots, reducing mortality from ghost fishing. 5) Potential for increased high grading that can be minimized by monitoring and regulation.	1) No incentive to race for harvest share, harvest decisions are driven by revenue and cost impacts. 2) Removes incentive to compromise safety to preserve harvest share. 3) Longer soak times could reduce bycatch. 4) Could reduce number of lost pots, reducing mortality from ghost fishing. 5) Potential for increased high grading that can be minimized by monitoring and regulation.

4.1.3 Projected processing sector composition and processing practices

This section examines the conditions in the processing sector. In the current LLP fisheries, processor entry is not limited by any direct regulation.[13] The three different rationalization alternatives offer different levels and types of protections to processors. The three-pie voluntary cooperative alternative would protect processors by allocating processing shares; the IFQ alternative provides no processor specific protection; the cooperative alternative limits entry to the processing sector and establishes linkages between cooperatives and processors. Because of these differences, the analysis of the processing sector under each rationalization alternative is separated.

Quantitative data that assist in the understanding of the differences of the alternatives are presented. These data are information such as the number of persons that would receive processing privileges and the limitations on holdings and use of those processing privilege under the alternatives. These data provide only a partial understanding of the processing participation and practices under the different alternatives because they do not predict whether individuals might choose transfer or use their privileges. The transfer and use of privileges by individuals will depend on several factors, including biological and economic factors and the management program created by the alternative. Because of the difficulty projecting fluctuations in crab stocks and harvest levels in the BSAI crab fisheries, no projections of specific numbers of processing facilities in the different fisheries are made. Instead the historical processing activity is used as the basis to develop an understanding of future processing activity under the different alternatives. Fluctuation in stock sizes and harvest levels are one impediment to projecting processor participation under the alternatives. In addition, accurate projection of participation would require extensive and detailed economic information concerning the industry. Revenue and cost data needed for this analysis is not available at this time. In addition, the novelty of some of the programs under consideration complicate the projection of practices of participants under the alternatives. For example, the processors protections and regional and community protection components of the different rationalization programs could limit the ability of processors to consolidate processing activity, since these aspects of the alternatives are likely to influence the geographic distribution of landings.

Processing sector participation and practices in the status quo alternative

The distribution of processing in the current fishery is not limited by direct regulation. Instead processing activity is limited by the economic conditions in the fisheries. Variations in processing participation and the geographic distribution of processing activity demonstrate some of the impacts of the current management system. Table 4.1-7 shows the number of locations (or communities) and plants at which processing occurred and the number of companies that processed crab in each of the fisheries and seasons between 1990 and 2000. The table shows that several facilities and companies have processed crab in the fisheries. In general, the number of plants and companies processing crab have declined in recent years, particularly when considering that fishery closures have shut down entire fisheries. With this exit of processing, some locations have lost processing altogether, while others have likely experienced some declines in the amount of processing.

[1] Some regulations, such as discharge limits, could effectively limit entry in some locations, but these regulations are directed at other objectives.

Table 4.1-7 Number of processors, companies, and plants in each of the Bering Sea and Aleutian Island crab fisheries (1990-2000).

	WAI (Adak) Brown King Crab			Aleutian Islands Red King Crab			Bristol Bay Red King Crab			Bering Sea C. opilio		
Season*	Locations	Companies	Plants	Locations	Companies	Plants	Locations	Companies	Plants	Locations	Companies	Plants
1990	1	3	3		closed			closed			closed	
1991	1	4	4	4	7	7	8	21	22	8	22	25
1992	3	6	6	5	7	7	6	17	18	8	19	20
1993	1	5	5	4	8	8	7	15	18	6	21	25
1994	4	7	7	3	7	7		closed		8	22	29
1995	1	5	5	1	3	3		closed		7	17	26
1996	2	5	5		closed		5	11	11	9	17	25
1997	1	4	4		closed		6	13	15	12	17	25
1998	1	2	2		closed		8	12	15	8	18	27
1999	2	5	5		closed		6	13	14	7	15	24
2000	2	6	6		closed		6	15	15	10	14	18

	Bering Sea C. bairdi			EAI (Dutch Harbor) Brown King			Pribilof Red and Blue King			St. Matthew Blue King Crab		
Season*	Locations	Companies	Plants	Locations	Companies	Plants	Locations	Companies	Plants	Locations	Companies	Plants
1990	7	19	22	1	4	4		closed			closed	
1991	7	21	23	2	5	5		closed		2	4	4
1992	8	24	28	2	4	4		closed		3	5	5
1993	9	22	25	2	6	6	5	11	13	3	9	10
1994	6	15	17	2	6	6	6	12	15	5	13	15
1995	7	13	15	1	4	4	5	10	11	4	7	9
1996	6	14	14	1	5	5	5	9	10	6	10	12
1997		closed		1	4	4	5	10	11	5	8	11
1998		closed		1	6	6	7	12	14	5	8	11
1999		closed		2	6	6		closed			closed	
2000		closed		2	4	4		closed			closed	

* Year in which season began (i.e., the 1990 season for the WAI (Adak) brown king crab is the 1990-1991 season).
Excludes some floating processors and catcher/processors, the location of which could not be determined.
Source: NPFMC Crab Rationalization Database Version 1 (2001).

EAI - easteran Aleutian Islands
WAI - western Aleutian Aslands

Under the current management, in the largest fisheries with the most vessels, the seasons are relatively short, with the entire harvest being made in the course of a few days or weeks. Processing typically occurs over the course of a few days after the closure of the fishery. Vessels queue at processing plants to offload crab. Workers process crab as rapidly as possible to complete the offloading with minimal deadloss, since crab must be processed live. Capitalization of the processing sector is determined based on the need to process crab in these short periods of time at the end of the seasons. Whether processing capacity would remain at its current level is dependent primarily on total harvests from the fisheries. Increases in stocks would likely stimulate increases in capacity at existing facilities, where capacity increases could be made at the lowest cost. If the current management is retained and stocks increase dramatically, processing facilities that have been removed could return to the fishery, particularly some of the floating facilities that could be reintroduced at relatively low cost. New processing facilities could enter the fisheries, if owners of existing facilities that process other species or entities in areas with an interest in the fisheries perceive an opportunity with crab stock increases. Since the current LLP management contains no direct limitation on processor entry, processor entry and exit decisions are made on an economic basis.

The geographic distribution of processing is dependent on several different, at times competing, factors. Processors often provide services to harvesters, including food, supplies, and gear storage. Access to transportation is important to processors that need to bring in workers and supplies (including those provided to harvesters) and ship product to markets. Proximity to fishing grounds can also be an important determinant of the distribution of processing activity. In years of large total harvests, harvesters make multiple deliveries.

Since travel time between the grounds and the processor is lost fishing time, distance to the grounds can be important to harvesters making in-season deliveries. In years of low total harvests (during which harvesters take a single trip), the distance to grounds is less important to harvesters, since traveling to and from the grounds will not reduce fishing time. The low total catches in recent years have reduced the importance of travel time to fishing grounds and may have resulted in some changes in the geographic distribution of processing activity from previous years. Whether this trend would continue if the current management is retained cannot be predicted and is dependent, in part, on stock levels. Stocks increases would be expected to increase the concentration of processing activity relatively close to the fishing grounds.

Output of the fisheries would likely be maintained in current forms, if the existing management is maintained. Brine frozen product is likely to remain a primary product, with blast and plate frozen crab being less important. Fresh and live crab and other specialty markets are likely to be pursued when the opportunity exists, but not at the expense of market share. Quality distinctions will continue to exist but are unlikely to gain additional attention. The time pressures of the race for fish are likely to limit the development of higher value products and greater quality distinctions. Additional information on product outputs and consumer impacts is found later in this section.

Processing sector participation and practices in the three-pie voluntary cooperative alternative

This section presents the analysis of processing practices under the three-pie voluntary cooperative alternative. The three-pie voluntary cooperative provides protection to processors through the allocation of processing shares. Since the allocation of processing shares is novel, the effects of those allocations on processor practices are not certain.

The three-pie voluntary cooperative would protect processors by the allocation of processing shares to processors for 90 percent of the TAC. As with the harvest allocations, the allocation of processing shares would be based on historic participation in the fisheries. For a processor to be eligible for a processing allocation, a processor must have processed crab in 1998 or 1999. Although on its face, this requirement may not appear to be stringent, the decline in participation in these two years has the effect of eliminating several processors from the initial allocation that participated in previous years. These processors, however, could be argued to have exited the fishery, justifying their exclusion from the initial allocation.

Figures 4.1-7, 4.1-8, and 4.1-9 show the distribution of processing share allocations.[14] As with harvesters, the allocations are grouped into four processor groupings to protect confidentiality. Processor groupings were made in descending order from the largest estimated allocation to the smallest allocation. The last and smallest grouping contains between four and seven estimated allocations, since at least four persons' activities must be included under confidentiality rules. The estimated allocation shown for each four processor group is the average allocation to members of that group. Allocations are shown as shares of the total processing allocation. Each legend shows the total number of processors that would receive an allocation in each fishery. Because allocations are averages, it is possible, particularly in the grouping with the largest allocation, that

[2] Processor allocations are aggregated at the company level based on processor facility ownership information verified with participating processors.

the largest allocation to a single processor is significantly different from the average of those four processors.[15]

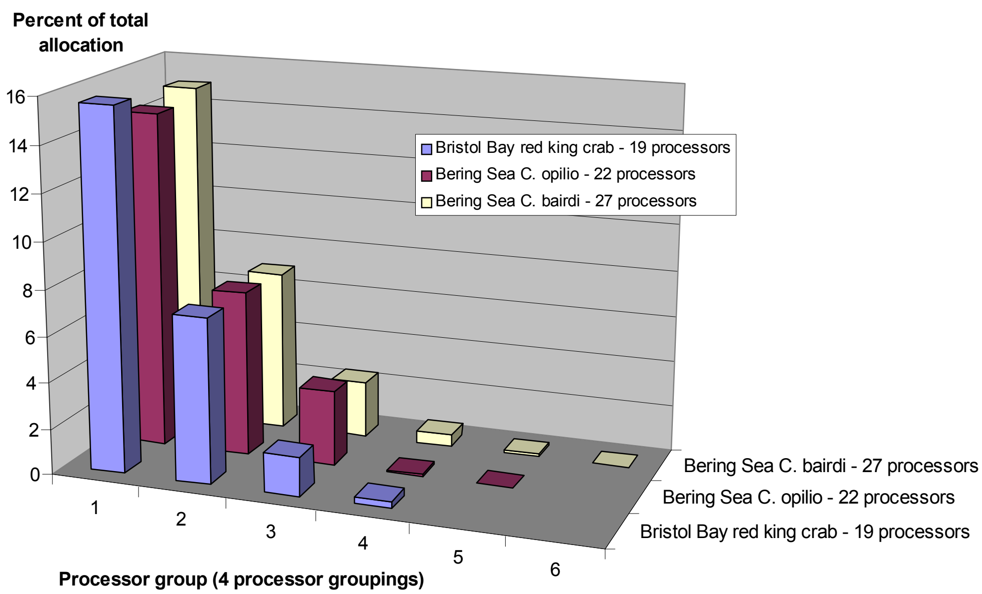

Figure 4.1-7 Processor share allocations in the Bristol Bay red king crab, Bering Sea *C. opilio* and the Bering Sea *C. bairdi* crab fisheries.
Source NPFMC crab rationalization database, 2001, Version 1

[3] The mean allocation is the average allocation. The median allocation is the allocation at the midpoint in the distribution, for which half of the allocations are larger and half of the allocations are smaller.

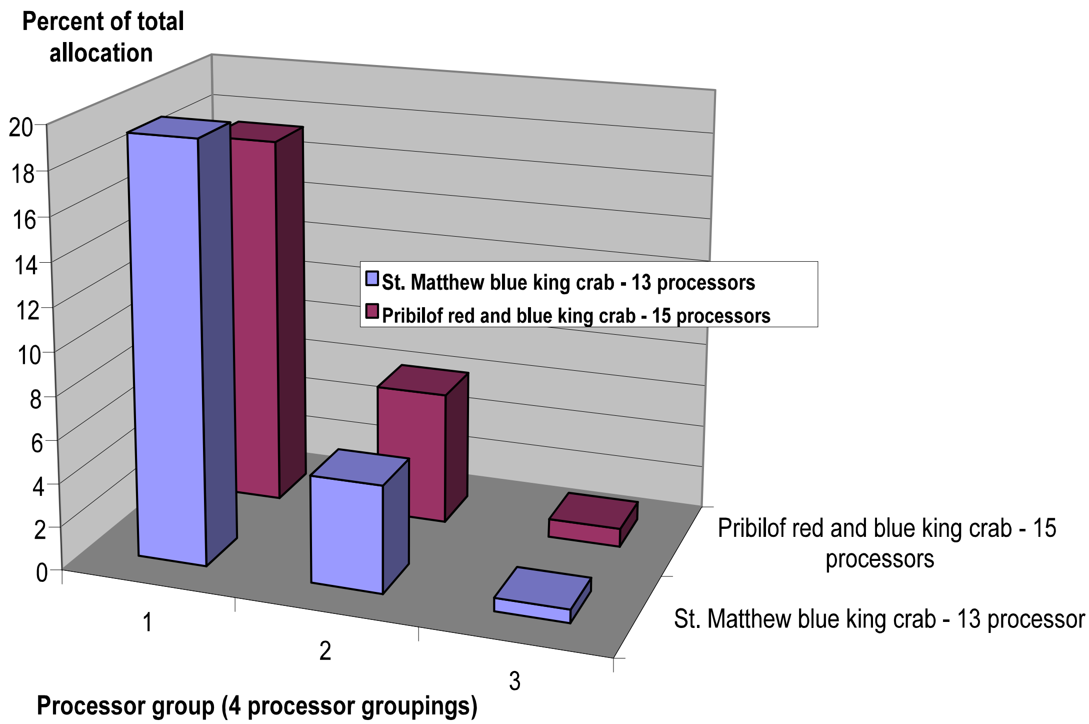

Figure 4.1-8 Processor share allocations in the St. Matthew blue king crab and Pribilof red and blue crab fisheries.

Source: NPFMC crab rationalization database, 2001, Version 1

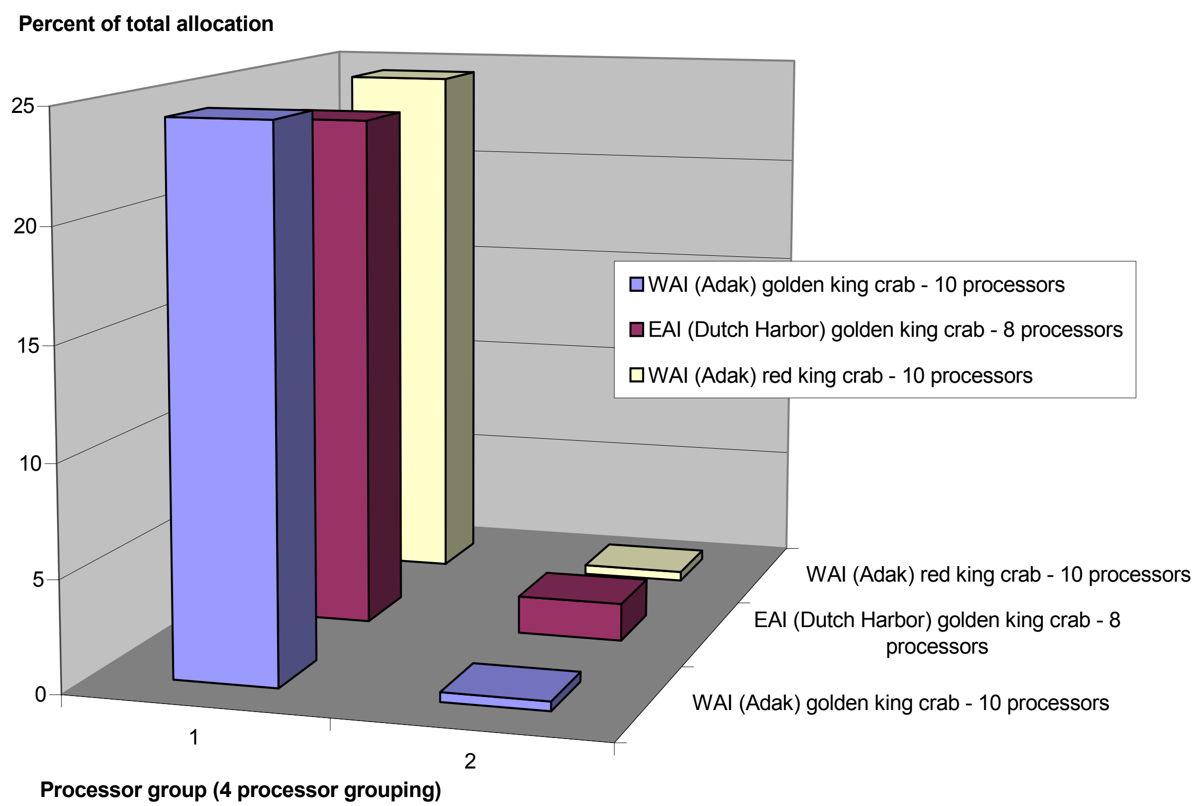

Figure 4.1-9 Processor allocations in the Aleutian Island king crab fishery.

Source: NPFMC crab rationalization database, 2001, Version 1
EAI - eastern Aleutian Island
WAI - western Aleutian Island

Processor allocations are substantially more concentrated than harvester allocations. This relative concentration occurs for two reasons. First and of greater importance, there are relatively fewer processors active in the fisheries than vessels active in the fishery. Second, more complete ownership information is available concerning processors. Processor allocations were aggregated to the company level. Company ownership of facilities was determined based on existing records with the assistance of processor representatives.[16] This allowed the analysts to obtain a fairly reliable ownership aggregation of facilities. Records of vessel ownership that are reliable are not available. Allocations of processing shares to C/P are included and are calculated in the same manner as for floating and shore based facilities, but are not aggregated at the company level because of the lack of vessel ownership data.

As in the harvest sector, processing allocation concentration varies across fisheries. The Aleutian Islands fisheries have the greatest concentration, with the four largest allocations exceeding 90 percent of the total allocation. The eastern Aleutian Islands golden king crab fishery has the largest median allocation, 6 percent. Only eight processors will receive an allocation in this fishery, so only four processors would receive allocations in excess of the median. In the Pribilof and St. Matthews fisheries, the allocations are slightly less concentrated with the four largest allocations making up between approximately 70 and 80 percent of the total allocation. These fisheries have median allocations of approximately 4 percent, showing that between six and seven processors would receive allocations larger than 3 to 4 percent. In the Bristol Bay and Bering Sea fisheries, the allocations to the four largest processors are approximately 60 percent of the total allocation. The low medians of these allocations together with the total number of processors receiving allocations show that approximately ten processors would receive allocations in excess of 1 to 2 percent. In addition, the graph of the allocations in these fisheries shows that approximately eight processors would receive allocations in excess of 5 percent.

Transferability and Use of Processor Interests and Limits on Holdings

Transferability of processor interests differs under the different alternatives. In the existing LLP fisheries and under the IFQ alternative, no processor licenses or shares would be created, so no transferable interest would exist and no issues arise concerning the use of a processing interest.

In the three-pie voluntary cooperative alternative, processor share allocations would be fully transferrable (including leasable) subject only to caps on share holdings and community rights of first refusal. Processing shares would be usable at any facility of a processor without transfer (subject to regional processing requirements).[17]

Ownership of processing shares would be limited to 30 percent of the outstanding shares in a fishery. In addition, in the *C. opilio* fishery no processor would be permitted to use in excess of 60 percent of the IPQs

[4] The facility ownership aggregations used by the analysts appear in Appendix 3-3 of the RIR, which is attached as Appendix 1 of this document. Some of the companies on that list have common owners. Peter Pan and Steller Sea have some common ownership, as do Westward Seafoods and Alyeska Seafoods. Depending on the rules chosen for determining ownership for purposes of applying caps, these companies with common owners might be considered a single entity. These companies were considered separate entities for purposes of the AFA.

[5] Community rights of first refusal grant crab dependent communities a right of first refusal on certain sales of processing shares from the community. Regional processing requirements constrain the use of shares. Both of these community protections are discussed later in this section.

issued in the Northern region. Regional processing use caps for other species were not included. The number of allocations in excess of the ownership cap in each fishery are shown in Table 4.1-8.

Table 4.1-8 Processor allocation statistics and share caps.

Fishery	Mean	Median	Average of four largest allocations	Number of processors	Allocations in excess of the 30% cap
Western Aleutian Islands (Adak) Golden King Crab	0.100	0.008	0.244	10	*
Western Aleutian Islands (Adak) Red King Crab[1]	0.100	0.008	0.244	10	*
Bristol Bay Red King Crab	0.053	0.017	0.156	19	0
Bering Sea C. Opilio	0.045	0.020	0.145	22	0
Bering Sea C. Bairdi (EBS Tanner Crab)	0.037	0.006	0.150	27	0
Eastern Aleutian Islands (Dutch Harbor) Golden King Crab	0.125	0.060	0.233	8	*
Pribilof Red and Blue King Crab	0.067	0.038	0.173	15	0
St. Matthew Blue King Crab	0.077	0.043	0.193	13	*

[1] Allocation is based on the WAI (Adak) golden king crab allocation.
[2] Witheld for confidentiality.
Sources: NPFMC Crab Rationalization Database, Version 1, 2001.

The slowing of fishing under the rationalization program creates an opportunity to remove additional capital from the processing sector. The removal of processing facilities from the fisheries, however, could be reduced by regional and community protections that geographically limit the ability of processors to concentrate processing. During the two year "cooling off" period, most processing is required to remain in the geographic location (e.g., community) that gave rise to the underlying processor shares. The effects of this provision on processing are likely to be limited in duration, but will likely extend beyond the two years that the provision will be in effect. After the two year cooling off period, the right of first refusal will limit the ability of processors to consolidate processing through the sale of processing shares. The limitations and exemptions on the right are likely to limit the effectiveness of the right and duration of its effect on fisheries. If community groups are able to use the provision to purchase interests in processing the long run distribution of landings and consolidation of processing could be impacted by the provision.

Regional designations on processing shares will require processors to process crab in one of two designated regions in most fisheries. Since the regional designations apply in perpetuity, the effects of regionalization will continue indefinitely. Since regionalization divides processing into only two geographic areas, its impact is likely to be weaker than those of the "cooling off" period or the right of first refusal. In terms of limiting consolidation, the most noticeable affect of regionalization is likely to occur in the season in which no processing would occur in a region, but for the regional requirements. While this is most likely to occur in seasons of low total harvests, the slower pace of fishing and the coordination of deliveries in a rationalized fishery could lead to the concentration of harvests in a single region in the absence of regional landing requirements. The specific effects of the regional landing requirements cannot be determined.

Consolidation in processing is likely to occur at two levels; long term consolidation and short term consolidation. Long term consolidation will occur through transfers of processor quota share (PQS) (the long term privilege processing shares). Processors that remain in the fisheries in the long run are likely to serve multiple fisheries. With the reduced time pressure from the end of the race for fish, processors will be able to realize cost savings by being active in several fisheries to prevent down time between landings that might arise if active in a single fishery. Most processors are likely to be active in both crab and fin fish fisheries; some processors, however, may concentrate on crab, serving multiple crab fisheries. Consolidation and adaptation to rationalized fisheries could require modification of existing lines and their configurations. Lines are currently set up for the throughput of large volumes of crab in a short period of time. In a rationalized fishery, the slow pace of processing may require some modifications that accommodate slow paced processing.

Short term consolidation (or expansion of processing) would occur through the transfer of IPQs or custom processing. IPQ transfers and custom processing are likely in years of large changes in the TAC, when processors will wish to make changes in the amount of capacity on relatively short notice and in years of low TACs, when processors that do not wish to go through the expense of opening a facility for a small amount of deliveries. In years of extremely low TACs, consolidation could be limited by the caps on processing share holdings. The free leasing allowed of processing shares, however, could result in extensive custom processing by PQS holders that choose not to be active in the processing sector, instead choosing to lease their shares.

Processing practices and products

Generally speaking, product and processing improvements will occur in a rationalized fishery. The change to a rationalized fishery creates the opportunity for the development of fresh and live crab markets since harvests can be dispersed over a greater time period. The extent to which these markets will develop cannot be predicted. New crab products could potentially be developed in a rationalized crab fishery. More uses for older shell crab and higher recovery, through increased meat extraction, could result. Better treatment of new shell crab, including using more time consuming blast and plate freezers instead of brine freezers, could improve quality.

In addition to the ability to provide more products to broader markets, rationalization may allow processors to improve product quality on more processed products. With longer periods of production, processors should be able to better train crews to handle and grade crab. The ability to produce higher quality products in a slower fishery is also evident from current processing in the CDQ fishery. Processors that participate in the CDQ fishery report that they postpone most of their production of high-quality products until the CDQ season when more time is available for processing. Better recovery and utilization should also result in increased quantities of low quality products that previously were sacrificed in the rush of crab through plants. Development of the different products could enable the fishery to expand into and better serve more markets and a broader range of consumers.

By creating a privilege to a share in the landings of a fishery, processor shares could affect processing practices. The combination of processing shares with the cooperative structure in the harvest sector is likely to contribute to the coordination of deliveries to each processing share holder and one or more associated cooperative fleets.

In the rationalized fisheries, fishing is likely to take place over a longer period of time. The distribution of fishing over time is likely to be limited by a few factors. Fishing is likely to be concentrated to realize optimum meat fill and to satisfy peaks in market demands. In addition, individual processors are likely to use negotiating leverage to concentrate deliveries to limit the amount of time they will need to have crews on hand. Processing of crab tends to be labor intensive in comparison to processing of fin fish. Crab processing also utilizes different equipment from other processing to the extent that processing for crab requires dedication of crews or space that would be used for other processing activities. Processors can be expected to time deliveries to have steady and uninterrupted flow of crab through their facilities. Some processors that are less active in fisheries other than crab are likely to bring in crews specifically for crab harvesting. Timing of deliveries is likely to be of even greater importance to these processors who might have a limited capacity to use crews during any down times between sporadic deliveries. Although many participants believe that processing shares provide the opportunity for coordination of processing activities, others believe that processing shares could dampen incentives to innovate or develop new products and markets. Whether processor shares have this effect could depend in part on whether harvesters can rely on the arbitration process to raise ex-vessel prices to a level that creates incentives for processors to aggressively pursue production improvements and new markets, or to sell their shares to processors that are willing to pursue those improvements and markets.

Since processing share holdings must be matched one-to-one with class A harvest share holdings, it is likely that each processing share holder will need to work with more than one cooperative. In addition, since cooperatives are not mandatory, some processing share holders may need to transact with individuals that choose not to enter cooperatives. The ability of a processing share holder to use the negotiating leverage created by processing shares to coordinate deliveries is likely to be affected by the extent to which harvesters enter cooperatives, and the relationships established by cooperatives. If a processor needs to work with several cooperatives, its ability to coordinate deliveries could be affected.

Processing sector participation and practices in the cooperative alternative

Under the cooperative alternative, processors are protected by processing licenses which are required for cooperative affiliations (Table 4.1-9). To qualify for a license, a processor must have processed crab in 1998 or 1999 (the same years that determine eligibility for an allocation in the three-pie voluntary cooperative). Thirty processors are estimated to be eligible for a license. A harvester's share allocation would be contingent on its membership in a cooperative associated with a licensed processor, creating a large incentive for harvesters to join a cooperative. In the first year of the program, a harvester would be eligible to join a cooperative associated with the licensed processor to which it delivered the most pounds in the year prior to program implementation. If a harvester failed to join a cooperative in any year, the harvester's allocation would be forfeited to all cooperatives on a pro rata basis. A cooperative would be required to deliver 90 percent of its allocation to the associated processor. The remaining 10 percent of the cooperative's allocation could be delivered to any processor, including processors that are not licensed.

Unlike the share allocations of the three-pie voluntary cooperative alternative, the specific distribution of the landings of the cooperative program among processors at the outset of the program are uncertain since cooperative affiliations are dependent on a harvesters deliveries in the year prior to implementation of the program. The need for four harvesters to form a cooperative creates an incentive for harvesters to deliver harvests to the relatively large processors active in multiple fisheries in the year prior to the implementation. If a harvester delivered the most pounds to a processor that did not receive a plurality of pounds from at least four harvesters in the year prior to implementation, then that harvester would forfeit its allocation in the first year of the program. Instead of delivering to large processors, it is possible that groups of harvesters could elect to form a cooperative around a small processor by agreeing to deliver to that processor in the year prior to program implementation to ensure that more than four harvesters would be eligible for cooperative formation. Harvesters might do so to avoid the uncertainties of a potential link to a large processor. Since a relatively large number of processing licenses are available in the fisheries, the number of cooperatives that would be established and the relative size of the processors that would associate with cooperatives cannot be predicted.

After the first year of the program, harvesters can unilaterally move between cooperatives. A harvester, however, would forfeit 10 percent of its shares to the cooperative that it leaves, for one year, unless the cooperative and the associated processor consent to the harvester's departure. The unpredictability of unilateral changes in cooperative affiliations by harvesters further limits the ability to determine the extent to which processing would consolidate under the cooperative alternative.

Processors are also permitted to transfer licenses, subject to a limitation that a processor can hold no more than two licenses. A license transfer would also transfer any cooperative association, so that different licenses could have different values in the market depending on the size of the associated cooperative.[18] The number of licensed processing companies could be reduced to as few as 15 if all licensed companies hold two licenses. Based on the number of companies that have participated in the fisheries historically, (with entry unrestricted) it is unlikely that processors will perceive a substantial advantage to purchasing a second license to limit competition. A company, however, may purchase a license from a competitor to increase its market share since the cooperative association would transfer with the license. The degree to which processing consolidation would occur through license purchases under this alternative cannot be predicted with certainty.

Slowing of the race to fish under the cooperative alternative is likely to result in the removal of capital from the processing sector. The degree of consolidation could differ from that of the three-pie voluntary cooperative alternative for several reasons. The absence of the regional processing requirements and community protections would tend toward greater consolidation of processing under this alternative than under the three-pie voluntary cooperative alternative. The choice of facilities to remove from the fishery will depend on several factors, including the availability of services, proximity to fishing grounds, and the reliability of transportation connections. The absence of geographic protections in the cooperative alternative are likely to drive any differences in the consolidation of processing between the cooperative alternative and the three-pie voluntary cooperative alternative.

Differences in the mechanisms by which processing interests are protected under the cooperative alternative and the three-pie voluntary cooperative alternative are also likely to affect the degree of consolidation[19] under the two alternatives. Under the cooperative alternative consolidation could occur in two ways. Processors could buy licenses and the cooperative association of that license. Because such a purchase is on an all-or-nothing basis, small scale consolidation is unlikely through the purchase of licenses. A second way that consolidation of processing can occur under the cooperative alternative is that a harvester can elect to change cooperatives (and thereby processors) provided the harvester is willing to forfeit 10 percent of its allocation for one year. So under the cooperative alternative, the decision to consolidate processing can be made by harvesters, who facing a price for changing the distribution of processing equal to harvester's return on 10 percent of a single year's landings. In years when the total harvests are low (and consequently the annual cooperative allocation attributable to the harvester's shares is relatively few pounds) the price for the transfer would be at its lowest. Harvesters in a weak financial position, however, might not be able to afford the price

[7] The difference in values of licenses arising from the cooperative association is difficult to predict. Since harvesters can unilaterally leave a cooperative by forfeiting shares to the cooperative, the benefits of purchasing a license to receive the cooperative association will depend in part on the willingness of a processor to agree to acceptable terms with the cooperative in long run.

[8] For purposes of this paragraph, consolidation refers to consolidation at the company level, rather than consolidation at the plant level. Distribution of interests among several companies would not preclude additional consolidation through custom processing relationships, which could occur under either the cooperative alternative or the three-pie voluntary cooperative. In the cooperative alternative, custom processing would require the consent of the associated cooperative, which could reduce the amount of consolidation through custom processing. The extent to which companies would choose to consolidate processing through custom processing under either alternative cannot be predicted.

in a year of low total income. Under the three pie voluntary cooperative alternative, the price that must be paid for changing the distribution of processing is the price of processing shares. The different levels of consolidation arising out of these different means of consolidation is highly dependent on the distribution of rents between the sectors under the different programs. Whether the different mechanisms by which processing is protected under the cooperative alternative and the three-pie voluntary cooperative have different effects on the level of consolidation of processing cannot be predicted.

Processing practices and products

Changes in processing practices are likely to be similar under this alternative to the changes that would occur under the three-pie voluntary cooperative alternative (Table 4.1-9). Processors are likely to coordinate deliveries with their associated cooperatives to improve product returns, develop more fresh products, and realize production efficiencies. The need to work with a single cooperative could improve coordination of deliveries under this alternative in comparison to the three-pie voluntary cooperative alternative. Quality and product improvements and product developments are likely to be realized once production is slowed with the end of the race for fish. Efforts would be made to develop new markets that do not exist currently because of the time pressures on processing under current management.

Processing sector participation and practices in the IFQ alternative

No direct regulation of the processing sector is incorporated into the IFQ alternative. Processors participation in the fisheries under this alternative will not be directly limited by the processor share and license requirements of the three-pie voluntary cooperative and cooperative alternatives (Table 4.1-9). As under the other rationalization alternatives, spreading fishing over longer seasons is likely to reduce the number of facilities necessary to process harvests from the fisheries. Free entry, however, could lead to the presence of more small processors that attempt to compete with larger more established processors or to serve small specialty markets that might otherwise be overlooked.

Under the IFQ alternative, the ability of processors to coordinate deliveries with harvesters could be complicated by the need to contract with several different IFQ holders. During the first few years after transition from current management to management under the IFQ alternative, deliveries are likely to be the least coordinated. Processors would likely attempt to use price incentives or affiliations with vessels to coordinate deliveries from harvesters. The success of any such efforts in the short run cannot be predicted. After a transition period, harvesters and processors are likely to coordinate deliveries to take advantage of benefits that can be realized through that coordination. The length of this transition cannot be predicted and could be extended if stock changes complicate stabilization of delivery relationships.

Regional landing requirements will affect the geographical distribution of landings under this alternative. These requirements could limit consolidation of processing, particularly in years of low TACs, when processing might consolidate in a single region at a few different facilities.

Table 4.1-9 Processor participation level and processing practices under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Processor participation level	1) Current participation level is maintained with fluctuation with stocks. 2) Existing facilities add capacity first, with entry of new facilities, if opportunity is perceived.	1) Temporal dispersion of fishing will facilitate removal of processing capacity from the fishery. 2) Landing requirements of processing shares, regionalization, and distribution of landings from community protections limit consolidation of processing. 3) Processing shares and cooperative structure facilitates coordination of deliveries.	1) Temporal dispersion of fishing will facilitate removal of vessels from the fishery. 2) Absence of processor landing requirements limit the ability of processors to coordinate deliveries, but higher ex-vessel price motivates coordination of deliveries in the long run.	1) Temporal dispersion of fishing will facilitate removal of vessels from the fishery. 2) Requirement that a cooperative land catch with its associated processor could limit. consolidation 3) Cooperative structure and landing requirements facilitate coordination of deliveries.
Processing practices	Current practices are unchanged as time constraints of the race for fish limit the ability of processors to develop new products or quality distinctions.	Reduced incentive to process landings quickly allows for emphasis on efficiency, product quality, and product development.	Reduced incentive to process landings quickly allows for emphasis on efficiency, product quality, and product development.	Reduced incentive to process landings quickly allows for emphasis on efficiency, product quality, and product development.

Processing practices and products

Changes in the processing practices are likely to be similar under this alternative to those under the other rationalization alternatives (Table 4.1-9). Processors will attempt to use the additional time made available by the slowing of the race to fish to improve quality and product returns, and to develop new products. It is possible that new products and markets that might be overlooked could be developed under this alternative. Whether any substantial new markets or a significant number of these small markets could be developed by this type of activity cannot be predicted.

Continuity among participating processors could be expected to differ more under this alternative than under the other rationalization alternatives. Processor entry is not directly limited and processors must compete to maintain market share without the market share protections of the other rationalization alternatives. As a consequence, greater turnover in processors should be expected. In any given year, the fisheries are likely to support both large and small processors. Some processors are likely to have extended tenures in the fisheries. Yet, individual processors are likely to grow and contract more rapidly under this alternative than under the other two alternatives.

4.1.4 Biological effects of rationalized fisheries management systems

Rationalization programs have been implemented for various fisheries throughout the world. Most of these programs are a variation of individual transferable quotas (ITQs) programs, called IFQ in Alaska, and cooperative programs. This section briefly summarizes biological effects from selected programs in order to understand the potential biological effects of the alternative rationalization programs considered in this EIS. These examples do not address processor quota shares and other elements of the alternatives in this EIS.

The fisheries management system of quota share allocation is an economic solution to the race for fish. Usually, the TAC would not change when the fishery management regime switches from derby fishing to a quota-based system. Therefore, if the TAC remains the same, any biological impact within a quota-based management system would be a unique product of that particular fishery's program. The following generalizations can be made about fisheries managed by an ITQ system and their biological consequences (some may not apply to the crab fisheries in Alaska).

- Negative biological impacts of ITQs could result from issues also occurring in traditional fishery management regimes: incorrect TAC settings, lack of enforcement, poor stock assessment, and scientific uncertainty.

- Bycatch amounts could increase if their catch levels are unlimited. Bycatch species could be targeted after the quota of the primary species is caught (Reichelt and Staples 1992). However, bycatch in the crab fishery could decrease if pot soak time increases, allowing undersized crab to exit the pot.

- Highgrading - dumping smaller, legal-sized catch - could be more likely to occur in an ITQ managed fishery. Fishermen have an incentive to fill their quota with the most profitable catch and to file false catch reports (Buck 1995). Furthermore, fishermen would have time to engage in highgrading because temporal limits would not exist under ITQ management. In the crab fishery, the incentive to highgrade, prompted by the market demand for larger crab, would not be controlled by ITQs.

- Detrimental effects on bottom habitat may not be concentrated in specific areas because fishing effort could spread out over the entire fishing area. However, this may not apply to crab fisheries because of the species' tendency to congregate and the type of gear used.

- Biological impacts in ITQ managed fisheries could occur if exploitable gaps in the management structure exist.

- Gear loss and ghost fishing would be reduced because fishermen would have more time to carefully set and retrieve pots.

Specific case studies below describe the biological effects in fisheries which have implemented ITQs.

Surf clam and ocean quahog - U.S. Mid and North Atlantic

The biology of the surf clam and the ocean quahog includes large annual variation in recruitment. In the 1960's and 1970's stocks were depleted in localized areas and low dissolved oxygen concentrations killed much of the New Jersey stock. In 1977, a moratorium was placed on the surf clam fishery, which led to increased development of the ocean quahog fishery (Wang and Tang 1994). In 1990, ITQs were implemented. The status of the surf clam and ocean quahog remains uncertain (National Resource Council [NRC] 1999). The ITQ management system allegedly encourages the targeting of large clams. However, fewer small clams are being discarded after ITQs were implemented because there is no minimum size limit. Although the fishery's vessel number did not increase, the harvesting capacity did increase.

South Atlantic wreckfish - U.S. South Atlantic

The south Atlantic wreckfish is a long-lived species. The fishery began in 1987 with two vessels catching 29,000 pounds of wreckfish. A huge expansion in three years resulted in 80 vessels catching 4 million pounds of wreckfish in 1990. ITQ implementation in 1992 was seen as a way to rationalize the fishery early. The biological outcomes of the ITQ management system include consistent landings that are lower than the TAC every year (NRC 1999).

Alaskan halibut and sablefish - U.S. Pacific Northwest and Alaska

Alaskan halibut and sablefish are both long-lived demersal species. The fishery began in the 1880's. Prior to IFQ implementation in1995, halibut biomass was above the 25-year average but declining. Sablefish had been declining since 1986 and was 30 percent below average at the time of ITQ implementation. After implementation of IFQs, sablefish catch rates increased despite the decreasing abundance levels (Sigler and Lunsford 2001). Mortality of halibut from lost gear and of bycatch dropped in the first year of ITQ implementation, but the data is somewhat uncertain. Bycatch in the sablefishery did not change. There was no evidence of under-reporting (NRC 1999). In the Gulf of Alaska (GOA), the TAC was frequently exceeded before IFQs and not exceed after IFQ management for both sablefish and halibut (Sigler and Lunsford 2001). The spatial and temporal distribution of halibut changed. Highgrading was unlikely to be profitable and was either not occurring or not great enough to be statistically significant (NRC 1999).

Sigler and Lunsford (2001) found two major effects of halibut and sablefish IFQ management: increased catch efficiency (in the GOA only) and decreased harvest of immature fish. Increased catch efficiency has resulted from the extension of the fishing season under IFQs. Changes in fishing practices under IFQs include fewer areas fished, greater proportion of the fishing conducted closer to port, gear set further apart, and crowding of the prime fishing areas reduced. Preferred fishing areas are less crowded and can be fished continually, while less desirable fishing areas are avoided. Conservation effects of these altered fishing behaviors have not been quantified, but one can extrapolate that unfished habitats would benefit from the concentration of harvesting effort elsewhere. Conversely, concentrated and sustained harvesting in the same area could be detrimental to benthic habitat in that harvested area. However, localized depletion of halibut or sablefish is less likely to occur when crowding on the fishing grounds decreases and the harvest is spread out over time.

Quantified conservation benefits seen under halibut and sablefish IFQ management include 25 million fewer hooks placed in the ocean each year and a $3.1 million per year decrease in fuel, bait and gear consumption (Sigler and Lunsford 2001). A reduced number of hooks equates to reduced number of snags on bottom structure and biota, particularly for fragile hard corals which are easily broken off, and potentially reduced bycatch (although neither of these reductions has been documented). A reduction in fuel, bait and gear has indirect environmental benefits, such as conservation of non-renewable resources and reduction in probable gear loss.

A decrease in the harvest of immature fish was also observed under halibut and sablefish IFQ management (Sigler and Lunsford 2001). This decrease improves the chance that an individual fish would reproduce at least once, called the spawning potential. An increased spawning potential, in other words, is the heightened possibility of each individual fish to bear offspring. Therefore, by decreasing the harvest of immature fish and allowing those fish to reproduce could have beneficial population impacts by increasing the overall number of fish.

Alaskan pollock - U.S. North Pacific, Bering Sea and Aleutian Islands

The Alaskan pollock commercial fishery developed in the 1980's through joint venture fishing operations between American harvesters and foreign factory ships. By 1991, foreign factory ships were replaced by U.S. factory trawlers and motherships. In 1998, a groundfish vessel moratorium was in effect, but the pollock fishery was already overcapitalized. Despite a fishing allocation scheme established between the inshore and offshore harvesters, the BSAI pollock fishery was essentially open-access, except for the small CDQ fishery. Partial rationalization of the BSAI pollock fishery occurred in 1999 and full rationalization in 2000. Rationalization occurred through the formation of fishery cooperatives, which divide up quota among cooperative members.

When the pollock fishery was undergoing rationalization, fishing patterns changed dramatically. There was a decrease in the pace of fishing and an increase in spatial dispersion on the fishing grounds (NMFS 2002c). In the same time period, fishing area restrictions were put into place to protect Steller sea lion habitat. Therefore, the observed increase in spatial dispersion of the pollock fishery cannot solely be attributed to rationalization. Greater dispersal of fishing effort in space and time can benefit species, such as sea lions and seals, by providing greater consistency in prey availability. Changes in the spatial distribution of the pollock fishery could alleviate fishing impacts on discrete populations of pollock. Dispersed fishing effort may also result in dispersed impacts to bottom habitat, and a slowed fishery may minimize accidental bottom contact by pelagic pollock trawlers. However, none of these potential benefits has been documented.

The already low discard rates in the pollock fishery increased slightly from 1998 to 2000, however this increase has been attributed to the Steller sea lion protection measures (NMFS 2002c). Bycatch rates are low due to the 1998 implementation of the Improved Retention/Improved Utilization FMP amendment, and have remained low throughout the rationalization process. Loosening of the seasonal restrictions for pollock resulted in the fleet fishing during summer months when salmon bycatch is typically higher. Bycatch of "other" salmon has increased, while bycatch of chinook salmon has substantially decreased (NMFS 2002c). Salmon bycatch limits are self-enforced within cooperatives and can therefore be more easily and quickly addressed than when NMFS was the enforcing agent.

After implementation of cooperatives in the pollock fishery, distance traveled by all vessels increased dramatically. Increased travel distance results in increased fuel consumption, which is an indirect negative environmental impact. This cannot be solely attributed to rationalization because Steller sea lion critical habitat area closures increased the travel distance required by the fleet. In fact, the harvesting flexibility provided by the cooperatives/quotas may have allowed pollock harvesters greater ability to comply with the Steller sea lion regulations (NMFS 2002c).

Cod and herring - Iceland

Iceland instituted ITQs over several years. The herring fishery, which collapsed in the 1970's, was placed under an ITQ system in 1979. The herring TAC has not been exceeded. The cod fishery recovered a small amount from an all time low after the implementation of ITQs. However, the cod TAC was exceeded for many years due to a small vessel exemption which was exploited. The number of small boats doubled from 964 boats in 1984 to 1,956 boats in 1990. Factory trawlers also increased in gross register tons (GRT) between 1984 and 1990, placing this added effort outside the Exclusive Economic Zone (EEZ). Additionally, an effort-quota alternative and the increase of total catch capacity (in GRT) in the fleet also made it difficult to enforce the TAC (Eythorsson 2000). Changes in bycatch levels or the occurrence of highgrading is unknown because they would have taken place at sea and were not observed.

Inshore and Deep-water fisheries - New Zealand

New Zealand implemented ITQs in the inshore fishery in 1986, with the goal of increasing long-term harvest. Fish stocks in New Zealand are typically medium or long-lived and do not generally experience large natural fluctuation in biomass (Davies 1991). The TAC was set in some areas based on average reported landings in time periods thought to be sustainable and in other areas set at 25 to 75 percent of the immediately preceding catch report. After ITQ implementation, bycatch problems were encountered and the TAC was both under-run and exceeded. Bycatch problems occurred because there was an "imbalance in the catch mix relative to the available quota" (Annala et al 1991) or in other words, quota was set for all species but the actual catch amount did not equal the quota amount. Many TACs were exceeded through misreporting, non-reporting, discarding of non-target species, highgrading, surrender of over-run to the Crown, use of catch/quota trade off, and a legal 10 percent over catch allowance. Highgrading increased when the quota of a non-target species was approached. The TAC of a target species was under-run when the non-target species quota was filled, stopping harvest of the target species. "A positive aspect of undercatching the TAC is that it helps to conserve the stock and possibly provides for some rebuilding" (Annala et al 1991).

4.2 Predicted effects of the alternatives on the life history stages of crab

Section 4.2 analyzes the effects of the alternative programs as a whole on the life history stages of crab. The potential effects of the crab fisheries, under all of the alternatives, are: mortality, reproductive success, and habitat. Significance criteria for these effects are outlined in Table 4.2-1. This section also details potential changes to crab fisheries management that address perceived effects.

Table 4.2-1 Significance Table for Crab. Criteria for determining the significance of direct and indirect effects of the BSAI king/Tanner crab fisheries on crab: significant adverse (S-), insignificant (I), or unknown (U).

Effects	Score		
	S-	I	U
1. Mortality	Level of mortality likely to delay recovery of population or decrease abundance below minimum stock size threshold (MSST).	Level of mortality resulting in no population level effect on species.	Insufficient information available for abundance estimates necessary to determine current stock status and identification of population level effects.
2. Reproductive Success	Fishery induced declines in level of recruitment success and adult fecundity that result in population level impacts or stock levels below MSST.	Reproductive success occurs within range of natural variability.	Insufficient information available on current reproductive status and relationship of spawning stock to recruitment success.
3. Habitat	Disruption or damage of habitat such that crab abundance declines to unsustainable levels or below MSST.	Impact to habitat unlikely to result in population level effects.	Insufficient information on the magnitude of habitat changes or inability to determine current status of crab habitat.

Table 4.2.-2 Summary table of effects of each alternative on crab stocks.

Effect	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Mortality	I	I	I	I
Reproductive Success	I	I	I	I
Habitat	I	I	I	I

Each of these effects of the alternatives on BSAI crab stocks are discussed below. Relevant issues were identified for each of these effects. Analysis of these issues provides a complete picture of all sources of crab mortality and provides an understanding of the effects of the alternatives on crab stock abundance. Indicators for each issue have been identified. These indicators are potential impacts of the alternatives, including status quo. Indicators are used as analytical tools for measuring significance and comparing the effects of each alternative on the issue. From the analysis, the extent to which each alternative results in an increase or decrease in each indicator will be able to be determined. Indicators can be mitigated by management measures incorporated into the preferred alternative or by changes to State management measures.

Mortality:

Issues associated with crab mortality:

- fishery sources of legal male mortality;
- fishery sources of female and sublegal crab mortality;
- stock rebuilding;
- fishery sources of non-target crab mortality; and
- harvest methods.

Analysis of these issues provides a complete picture of all sources of crab mortality and an understanding of the effects of the alternatives on crab stock abundance.

Fishery sources of legal male crab mortality: Harvest strategies have been developed for the crab fisheries that set the harvest levels to for the removal of legal-sized male crabs. These harvest strategies set harvest levels that maintain healthy stock abundance by incorporating the best available scientific information on fishery sources of mortality and survey data. The goal of crab fisheries management is to allow a harvest rate that maintains stock abundance at the level necessary to produce the maximum sustainable yield (MSY). This is a challenge for crab stocks because crab stocks experience natural cyclical levels of abundance. NOAA Fisheries annually assesses crab abundance for the stocks under consideration for the rationalization programs, except for Aleutian Islands red king crab and Aleutian Islands brown king crab, which are periodically assessed by ADF&G.

> *Harvest above the guideline harvest level (GHL)*: Potential effects of the different alternatives will be estimated based on the extent to which the harvest amount exceeds the harvest level. Harvests that exceed the GHL are difficult to prevent in the derby-style fisheries. Even with good in-season assessment and catch reporting, catches can change rapidly and a large efficient fleet can quickly surpass a harvest target when they locate high concentrations of crab. When stocks are low, management difficulties increase and actual harvest often exceeds the pre-season harvest limit.
>
> *Highgrading*: Potential effects of the different alternatives will be estimated based on the extent the fishery practices highgrading. Highgrading is sorting through the legal crab for the largest, cleanest crab, and discarding the remaining legal crab to ensure that only the highest-priced portion of the catch is landed. Some of this discarded crab dies. This leads to additional fishing mortality of legal males in excess of the harvest level. Highgrading is an environmental concern because it may alter the composition of the stock by removing only the largest male crab. These crab are also thought to be the most successful at mating.

Deadloss: Potential effects of the different alternatives will be estimated based on the amount of deadloss. Deadloss is dead crab landed at the dock. Deadloss is a direct result of the amount of time a crab spends in the boat. Deadloss can be increased by having diseased or dead crab in the tank with live crab. If the deadloss is accounted for when crab is landed, then deadloss is not a biological problem because these are crab accounted for in the GHL. If deadloss is discarded at-sea, then it negatively effects crab abundance because this mortality is not accounted for.

Fishery sources of female and sublegal male crab mortality: The main source of female and sublegal male crab mortality is bycatch in the crab fisheries. All bycatch is discarded. Managers estimate that up to 25 percent of discarded crab die from handling. This is a precautionary estimate used for calculating total removals by the fishery, and includes unobserved mortality.

Bycatch: Potential effects of the different alternatives will be estimated based on the amount of female and sublegal male crab bycatch in the crab fisheries.

Stock rebuilding: Rebuilding plans for the overfished crab stocks implement conservative harvest strategies that promote stock rebuilding. Rebuilding plans close fisheries when the stocks decline below a threshold abundance level. The term overfished is used to define stocks at low levels of abundance, regardless of the causes of the low abundance. Currently, many crab stocks are in periods of low abundance and NOAA Fisheries has declared four stocks overfished.

Abundance of overfished stocks: The analysis will examine the extent the alternatives promote management under the rebuilding plan by reducing crab mortality and increasing crab stock abundance.

Fishery sources of non-target crab mortality: The crab fisheries catch and discard crab species not targeted by the fishery. A portion of this bycatch dies from handling mortality.

Bycatch of non-target crabs: Potential effects of the different alternatives will be estimated based on the amount of bycatch of non-target crab species in the crab fisheries.

Harvest methods: The methods of harvest include when the harvest occurs, the fishing effort, and how the crabs are handled. Harvest methods also include the extent to which fishermen comply with regulations. Harvest methods impact the crab resources by causing mortality of legal male crabs in excess of the harvest level, and causing mortality of female and sublegal crabs of the target species and non-target crabs.

Handling of crab: Potential effects of the different alternatives will be estimated based on the rate of handling mortality, which is the rate that captured crabs die. Handling mortality depends on when the crab are harvested and how the crabs are handled on deck. The time of year when crab are harvested effects the crab survival rate. Evidence indicates that crabs captured in extremely cold and windy weather suffer higher rates of handling mortality. Crab captured when they are soft-shelled suffer a higher mortality than hard-shelled crabs. Also, capturing crabs during mating disrupts mating and can negatively effect reproduction. Fishing during these biologically sensitive periods can negatively effect crab abundance.

Season length and the pace of the fisheries influences handling mortality. With short seasons, crab are harvested very quickly and no time is afforded to carefully handling crabs. Longer fishing seasons slow down the pace of the fisheries and allow the fishermen to improve fishing methods, such as gear operation and sorting on deck. Also, with more time, fishermen would be able to improve handling methods and reduce the mortality of all crabs brought on deck.

Harvest effort: Harvest effort is the amount of vessels and gear deployed to catch the harvest limit. Harvest effort above the amount required to catch the harvest limit results in crab harvests above the limits, increased bycatch, and increased habitat impacts. Excessive harvest capacity also causes wasteful fishing practices and results in the fleet deploying more pots than could be retrieved during a short fishing season, which results in lost pots. Potential biological effects of the different alternatives will be estimated based on the amount of harvest effort in relation to the harvest level.

Manageability of fisheries: Potential effects of the different alternatives will be estimated based on the manageability of the fishery and the extent of monitoring. Because the goal of most management measures is conservation, the increased ability of managers to ensure compliance with harvest limits and other regulations has stock conservation benefits. Monitoring provides information to managers on the amount of catch and bycatch, and the location of harvest. This information is vital for setting the harvest levels and measuring the effectiveness of bycatch reduction measures. Data collection is important for establishing the scientific foundation on which the fishery is managed. Improved manageability of the fisheries will have positive effects on stock abundance.

Reproductive success

The reproductive success of crab stocks determines the abundance levels. Reproductive success is due to a combination of many factors, many of which are not fully understood by scientists. Fishing pressure can influence a stock's reproductive success. The indicators for this issue are three ways that fisheries may impact a stock's reproductive success.

Change in ratio of males to females: Potential effects of the different alternatives will be estimated based on the extent the fishery causes changes to the ratio of males to females.

Decrease in the size of male crabs: Potential effects of the different alternatives will be estimated based on the extent the fishery causes a decrease in the size of male crabs.

Genetic diversity: Potential effects of the alternatives will be estimated based on the extent the fishery removes segments of a population impact a stock's genetic diversity by reducing the population size and/or removing segments of a population.

Habitat:

The effects of the alternatives on habitat are analyzed in section 4.3.2. From this analysis, it will be determined if the habitat effects cause crab abundance to decline to unsustainable levels or below the MSST.

4.2.1 Larval, settlement, and juvenile crab life stages

The life history stages for king and Tanner crabs are described in Section 3.2.1 and Section 3.2.2, respectively.

Larval crab

Information presented in Sections 3.2.1 and 3.2.2 shows the crab fisheries do not impact movement or feeding of king and Tanner larval crab, which occurs in the water column. Likewise, the fisheries do not catch crab larvae. Therefore, it is concluded that the alternatives do not directly effect larval crab. The only potential relationship is between crab spawning stock abundance and larval production. Most research and population modeling does not show a spawner/recruit relationship. This means that the influences of spawning biomass abundance on the subsequent abundance of crab larvae cannot be determined. However, to be precautionary, it is assumed that removal of males by the fishery does reduce larvae abundance, but that level of reduction is not distinguishable given current scientific information. It is logical that a high harvest rate would negatively effect larval production and abundance, but that no other crab management measure would impact larval crab. Because harvest rates are set conservatively, it is concluded that the fisheries have an insignificant effect on larval crab. Likewise, it is concluded that Alternatives 2, 3 and 4, because they would not change the harvest strategies or amount of crab harvested, would have an insignificant effect on larval crab.

Settlement - early juvenile stage

As crab larvae matures, it moves from the water column to the ocean floor. Where crab settle and are able to survive depends on currents and suitable habitat. Newly settled crab are too small to be captured in pot gear, and the fishery does not effect the food availability for this size of crab. The main effect a crab fishery would have on this life stage would be destruction of habitat, when the fishery occurs at the same location as settlement. This is especially true for king crabs. As explained in Section 3.2, suitable habitat for king crab includes living organisms. It is these living organisms that can be damaged by fishing gear. The effects of pot gear on benthic species is discussed in Section 4.4, under the EFH assessment. From this assessment, it is concluded that the current crab fisheries have an insignificant effect on crab habitat or benthic species. It is concluded that the alternatives also have insignificant effects on this life stage of crab because none of the alternatives will change the nature of pot gear or increase the amount of pot gear deployed.

Juvenile stage

The category of juvenile crab encompasses a broad range of sizes, from very small crab to larger crab just before sexual maturity. The juvenile stage of each crab species is discussed in Section 3.2. Larger juvenile crabs are captured as bycatch in the crab fisheries. Bycatch of larger juvenile crabs is discussed in Section 4.2.2 along with bycatch of female crabs. Smaller juveniles, which are not captured as bycatch because they are too small, are not measurably effected by the fisheries. When crab fisheries do occur in areas with juvenile crab, and the crab are too small to be captured in the pots, it is assumed that mortality is low. It may be possible that juvenile crab are impacted as pots land on the sea floor. However, this hypothetical impact has not been documented. Taking into consideration these direct and indirect effects, it is assumed that the impacts of the crab fisheries on small juvenile crab are insignificant. The alternatives under consideration would not change how the crab fisheries effect small juvenile crabs.

4.2.2 Adult crab

The FMP management structure would not change under any of the alternatives, although specific management measures would change. Predicted changes to the crab fisheries under each alternative are described in Section 4.1. In summary, the projected retained catch of crab species from the BSAI does not vary under any of the alternatives. None of the alternatives would affect the process under which harvest levels are established and it is assumed that the entire allowable harvest amount would be harvested under each of the alternatives. Bycatch of female and sublegal male crabs, as well as other species, is expected to decrease due to changes in fishing practices and increased monitoring. However, discards of legal crab may increase if the fleet has incentives to highgrade.

4.2.2.1 Alternative 1

The effects of status quo on adult crab have been analyzed extensively in environmental assessments (EAs) prepared for each FMP amendment and in State publications. A complete list of the EAs is in Section 3.4.2. Current management, as described in Section 2.1, regulates the fisheries according to the objectives and goals established in the FMP. The crab fisheries predominantly effect the target stock and other species of crab caught as bycatch. The main ways a fishery effects the crab stocks are the amount removed, the amount discarded, harvesting and handling methods, when the fisheries occur, and where they occur. The harvest strategies dictate how much is removed. Discards at-sea are monitored by the observer program. Harvest and handling methods are a result of fisherman behavior and regulations. Season dates are set by regulations and season duration is determined by amount of available harvest. The fishery location is predominantly determined by aggregations of large males of the target species.

Legal male crab mortality

In each BSAI crab fishery, the fishery harvests legal sized male crabs of the target species. ADF&G has established harvest strategies to determine the GHLs based on stock abundance and composition of the stock. Abundance estimates from the NOAA Fisheries trawl surveys are incorporated, along with fishery data, into models. The harvest strategies close fisheries when abundance is below established thresholds and allow conservative harvest rates when abundance warrants a fishery. The predicted effects of these harvest strategies on the crab stocks are detailed in following State reports: “Overview of Population Dynamics and Recommended Harvest Strategy for Tanner Crabs in the Eastern Bering Sea” (Zheng and Kruse 1999); “Overview of Recommended Harvest Strategy for Snow Crabs in the Eastern Bering Sea” (Zheng et al. 2002); “Overview of Stock Assessment and Recommended Harvest Strategy for St. Matthew Island Blue King Crabs” (Zheng and Kruse 2000c); “Overview of Population Estimation Methods and Recommended Harvest Strategy for Red King Crabs in Bristol Bay” (Zheng et al. 1996a); and “Evaluation of Alternative Harvest Strategies For Bristol Bay Red King Crabs” (Zheng 2003). These reports explain how the harvest strategies were developed to maintain crab populations comprised of various size and age classes in order to maintain long term reproductive viability of the stock and reduce industry dependence on annual recruitment, which is extremely variable. These reports also analyze alternative harvest strategies and model the long-term effects of each harvest strategy on the crab stock.

To reduce the impacts of harvesting on crab stocks, current harvest rates for eastern Bering Sea crab stocks are generally a function of stock abundance, with high rates on high stock abundance, low rates on low stock abundance, and no harvest when the stock abundance being below a threshold. The highest mature male harvest rate among all crab stocks in the eastern Bering Sea is 22.5 percent for snow crabs. Mature female abundance is generally similar to or higher than mature male abundance for a crab stock. Therefore, current mature harvest rates on total male and female mature abundance are less than 11.3 percent for any crab stock in the eastern Bering Sea, much lower than the "presumed" natural mortality of 0.2 or 0.3 (NPFMC 1998a).

The harvest strategies for Tanner crab, snow crab, and St. Matthew blue king crab were analyzed in the EA for each rebuilding plan amendment. The EAs demonstrate how these harvest strategies promote stock rebuilding within the prescribed time period. These rebuilding plan amendments are discussed in Section 3.4.2.

Fisheries sources of legal male crab mortality of the target species that are not accounted for in the harvest strategies negatively impact the stocks because this is harvest above the level determined sustainable for crab abundance. Two points for analysis are whether legal male crab mortality occurs in excess of the guideline harvest level and whether or not it occurs at a level that significantly effects crab stock abundance. Indicators of legal crab mortality in excess of the GHL are harvest above the GHL, highgrading, and deadloss. It is a challenge for managers to determine how to include these sources of mortality in the harvest strategies. Based on the analysis of each of the indicators below, the effect of unaccounted for mortality on legal male crab abundance is insignificant.

Indicator: Harvest above the GHL

Under status quo, actual harvest levels often exceed the GHL due to managers inability to close the fishery in a timely manner due to inadequate fishery information. Conversely, inadequate fishery information sometimes leads managers to close the fisheries prior to reaching the GHL. Premature closures result in forgone income for the fleet. Harvests over and under the GHL are calculated into the stock abundance models used in setting the GHL the following year. The biological effect of overharvest is that the fishery removes more than deemed sustainable by managers.

The amount of harvest above or below the GHL differs among fisheries, and depends on the GHLs and the number of participating vessels. In the snow crab fishery, during the past five years, the harvest was below the GHL for two years and above the GHL for three years. Over that five year time span, the actual harvest was on average 1.06 million pounds above the GHL (Table 4.2-3). The harvest of Bristol Bay red king crab was also below the GHL for two of the last five years. On average, the actual harvest is .5 million pounds above the GHL (Table 4.2-4). The Aleutian Islands golden king crab fishery actual harvest has also been below the GHL in two of the past five years. However, because the Aleutian Islands golden king crab fishery is slower paced with fewer vessels participating, the amount of harvest above and below the GHL is small. In fact, on average, the fishery has harvested .4 million pounds below the GHL (Table 4.2-5). The Tanner crab, St. Matthews blue king crab, and Pribilof Islands blue king crab fisheries are closed.

Table 4.2-3 Harvest amount compared to the guideline harvest level for snow crab 1999-2003.

snow crab fishery	Harvest	GHL	Difference	Abundance*
1999	184.5	186.2	-1.7	337.1
2000	30.8	26.4	4.4	130.8
2001	23.4	25.3	-1.9	102.1
2002	30.3	28.5	1.8	102.2
2003	26.3	23.6	2.7	94.4
Average harvest above GHL			**1.06**	

Note: values in millions of pounds.
*Abundance estimates of male crabs greater than or equal to 4 inches in carapace width. For snow crab, the abundance estimate is based on the previous year's trawl survey (1998 survey for the 1999 fishery).
Source: 2002 SAFE document (NPFMC 2002), AFSC Kodiak Lab.

Table 4.2-4 Harvest amount compared to the guideline harvest level for Bristol Bay red king crab 1998-2002.

Bristol Bay red king crab	Harvest	GHL	Difference	Abundance*
1998	14.2	15.8	-1.6	46.3
1999	11	10.1	.9	63.1
2000	7.5	7.7	-.2	50.4
2001	7.8	6.6	1.2	33.6
2002	8.8	8.6	.2	61.1
Average harvest above GHL			**.5**	

Note: values in millions of pounds.
*Abundance estimates of legal male crabs.
Source: 2002 SAFE Document (NPFMC 2002), AFSC Kodiak Lab.

Table 4.2-5 Harvest amount compared to the guideline harvest level for Aleutian Islands golden king crab 1998-2002.

Aleutian Islands golden king crab	Harvest	GHL	Difference
1997/98	5.9	5.7	.2
1998/99	4.9	5.7	-.8
1999/00	5.8	5.7	.1
2000/01	6	5.7	.3
2001/02	5.5	5.7	-.2
Average harvest below GHL			**-.4**

Note: values in millions of pounds. Abundance estimates not available for AI golden king crab.
Source: 2002 SAFE document (NPFMC 2002).

For the crab fisheries currently open, harvests above the GHL do occur in some years. The question, then, is whether or not this harvest amount occurs at a level that significantly effects abundance of legal sized male crab. As evident from this information, the amount of harvest above the GHL is nominal compared to the level of abundance of this segment of the crab population. Therefore, the effects of the fisheries' harvests above the GHL on the legal male crab abundance are insignificant.

Indicator: Highgrading

Highgrading, also known as fishery selectivity, is the sorting through of legal crab for the largest, cleanest crab, and discarding the remaining legal crab to ensure that only the highest-priced portion of the catch is landed and counted against the quota. Some of this discarded crab dies. This leads to additional fishing mortality of legal males in excess of the quota. Highgrading is an environmental concern because it may alter the composition and hinder the reproductive capabilities of the stock by removing only the largest, cleanest crab. Highgrading is driven by market forces and preferences for clean shelled crab.

Highgrading occurs to some extent under status quo. Highgrading is motivated by the fact the processors pay less for or refuse to accept dirty crab. Also, fishermen discard damaged crab that may die in the tank because dead crab decrease the survival rate of the live crab around them. As an illustration of the amount of highgrading, Table 4.2-6, shows the amount of legal crab discarded in each BSAI crab fishery in 2000. Fishermen sort snow crab and Tanner crab on deck to discard crab under four inches in carapace width and "dirty crab", also called old-shelled crab, crab with broken shells or missing limbs. Highgrading is less prevalent in the king crab fisheries, where only very old shelled crab or damaged legal males are discarded.

With sex and minimum-size restrictions for retention, there is inherent fishery selectivity in the BSAI king and Tanner crab fisheries. Nonetheless, it is the policy of the BOF to "maintain crab comprised of various size and age classes of mature animals in order to maintain long term reproductive viability of the stock and reduce industry dependence on annual recruitment, which is extremely variable." The State harvest strategies currently address this policy by setting caps on the harvest rate of the size-shell component of legal males that are selected for retention in the fishery. In the king crab fisheries, where there is currently little evidence for strong fishery selectivity within the class of legal-sized males, the harvest rate cap is applied to the preseason abundance of legal-sized males. In the both the Bering Sea Tanner crab and snow crab fisheries, however, there is strong selectivity by the fishery for legal males in new-shell (clean-shell) condition as opposed to old-shell (dirty-shell) condition. In the Bering Sea snow crab fishery, processor standards for delivered crabs also results in strong selectivity for males with greater than or equal to 4-inches carapace width (CW), although the legal size is 3.1 inches CW. Accordingly, the harvest strategies for the Bering Sea Tanner crab and snow crab fisheries apply the harvest rate cap to exploitable legal males, which is a subset of the legal males defined on the basis of fishery selectivity for shell condition, size, or both. Additionally, harvest strategies developed for Bering Sea king and Tanner crab stocks since the mid-1990's account for assumed bycatch and handling mortality of non-retained crabs in the determination of the harvest rate on mature- or legal-sized males.

Due to the fact that existing highgrading is accounted for in the harvest strategies in that the harvest rates are applied to the portion of the population actually caught by the fishery, and that the harvest rates are conservative, the effect of highgrading on legal male crab abundance is insignificant.

Indicator: Deadloss

Deadloss is the amount of dead crab landed at the dock. All deadloss is discarded because it cannot be sold. As long as all deadloss is landed, it is an economic problem rather than a biological problem, because deadloss is deducted from the GHL. In years when GHLs were very high, deadloss amounts were also high. Vessels were not able to off-load quickly and many crab did not survive the wait. With more processing capacity, improvements in technology, and smaller GHLs, deadloss has decreased in recent years. Additionally, due to the short seasons, fishermen do not have the incentives to sort out deadloss for discard at-sea. Under the status quo fisheries, deadloss is estimated to be about 1 to 2 percent of all crabs landed. Therefore, the effect of deadloss on legal male crab abundance is insignificant.

Crab Bycatch issues

In the crab fisheries, crab bycatch includes females of target species, sublegal males of target species, and non-target crab. In the snow crab fishery, bycatch also includes legal males smaller than the 4-inch industry preference. The crab fisheries also catch small amounts of other benthic species as bycatch, this bycatch is discussed in section 4.3.1. All bycatch is discarded at sea.

Bycatch of female and sublegal male crab. The main source of female and sublegal male crab mortality is bycatch in the crab fisheries. The ADF&G observer program collects bycatch data on observed vessels (Table 4.2-6). This table illustrates the crab bycatch composition and discards for the BSAI crab fisheries. The observed bycatch of the target species is extrapolated to estimate total bycatch for the whole fleet. The observed bycatch of other crab species is in numbers actually observed, and does not represent a fleet total. Except for the snow crab fishery, where the bycatch of Tanner crab and hybrid crab are extrapolated to estimate total bycatch of these crabs. As shown in the table, most bycatch in the king crab fisheries is female and sublegal males of that species. Bycatch is highly variable in the Bristol bay red king crab fishery, sublegal male discard catch has varied between about 50% to 200% of the retained catch from 1992 to 2002, and has averaged about 110% of the retained male catch for that period (ADF&G 2003). The ADF&G observer data report (ADF&G 2003) shows that bycatch of sublegal males in king crab fisheries can exceed the catch of retained legal males (in numbers), and the catch of females in the king crab fisheries also can exceed the catch of retained legal males (in numbers). This means that discard of sublegal males and females can be more than twice the retained legal catch. Most bycatch in the snow crab fishery are legal males smaller than the 4-inch industry preference.

Table 4.2-6 Bycatch estimates (in numbers of crab) for crab species in year 2000 Bering Sea and Aleutian Island crab fisheries.

Fishery	Bycatch Species	Legal discards	Sublegal discards	Female discards	Total Bycatch
Snow crab fishery	snow	3,928,000	221,000	17,000	4,166,000
	Tanner/snow hybrids	153,000	17,000	0	170,000
	Tanner	3,000	272,000	68,000	343,000
	blue king*	2	7	0	9
Bristol Bay red king crab fishery	red king	3,000	1,313,000	227,000	1,543,00
	Tanner*	223	382	36	641
	snow*	920	16	1	937
	hybrid*	158	5	1	164
Golden king crab fishery	golden king	82,000	1,963,000	2,003,000	4,048,00
	scarlet king*	330	79	75	484
	Grooved Tanner*	14	2	4	20
	Tanner*	0	4	1	5
	hybrid*	0	0	1	1

Notes: Tanner crab, St. Matthew blue king crab, and Pribilof king crab fisheries are closed.
* indicate actual numbers observed, not fleet wide estimates.
Source: ADF&G Observer Program data (ADF&G 2003).

Bycatch of non-target crab. The amount of non-target crab caught as bycatch in directed crab fisheries is detailed in Table 4.2-6. These crab experience handling mortality as discussed below. As shown in this Table, the directed crab fisheries do not catch a lot of bycatch of other crab species compared to each species total abundance. This varies by fishery and by year. In some years, the Bristol Bay red king crab fishery catches a large number of Tanner crabs. In the Pribilof king crab fishery, both red and blue king crab are targeted. To avoid bycatch of blue king crab when the abundance of blue king crab is low, the red king crab fishery is closed. A small fishery for scarlet king crab existed in conjunction with golden king and grooved Tanner crab fisheries (ADF&G 2001). All scarlet king crab caught as bycatch in snow and Tanner pot fisheries from the Aleutian Islands in 1995-1996 were included in the dedicated fishery for scarlet king crab. Since 1997, there has been little to no effort dedicated to scarlet king crab and there was no harvest in 2000. Non-target crabs are also caught by lost pots, also called ghost fishing. Ghost fishing is discussed in Section 4.3.1.2.

Total bycatch. Table 4.2-7 provides estimates of the numbers of each species of crab caught as bycatch in all crab fisheries. Some amount of discarded crab die due to being hauled up, handled, and thrown back overboard, which is called handling mortality. Handling mortality is discussed under the harvest methods in this section.

Table 4.2-7 Bycatch estimates (in numbers of crab) in all Bering Sea crab fisheries combined, 1994-2001.

Year	Snow crab	St. Matt's blue king	Bristol Bay red king	Tanner crab
1994	53,082,564	3,848,080	18,600	19,003,200
1995	48,734,000	confidential	0	15,897,300
1996	56,570,785	1,600,333	605,000	4,588,000
1997	75,005,446	confidential	985,000	4,865,900
1998	51,591,453	confidential	4,593,800	4,293,800
1999	47,093,200	n/a	957,800	1,995,100
2000	5,020,800	54,400	1,701,000	491,000
2001	6,123,300	1,300	2,419,000	626,400

Source: NPFMC's 2002 BSAI crab SAFE Report

Effects of bycatch mortality. By applying mortality rates estimated from scientific observations to the number of crabs taken as bycatch, it is possible to estimate the relative impacts of bycatch on crab populations. In this discussion, bycatch only includes discarded legal males, sublegal males, and females of the target species. Discard mortality rates have been estimated for specific species or fisheries for analytical purposes. Rates used are 24 percent for snow, 20 percent for Tanner, and 8 percent for blue king crab and red king crab (NPFMC 2002). Note, however, that there is a high level of uncertainty in the discard mortality rates due to the fact it is difficult to determine with certainty how many crab that are discarded at-sea actually die. A more complete discussion of discard mortality is below under *harvest methods* in this section. Tables 4.2-8, 4.2-9, 4.2-10, and 4.2-11 show the resulting discard mortality estimates, the estimated population size based on the NOAA Fisheries trawl survey, and the estimated percentage of the population removed due to bycatch mortality.

The harvest strategies and abundance models for the BSAI crab fisheries incorporate estimates of bycatch mortality in determining the stock abundance and GHLs to ensure that bycatch does not negatively impact stock abundance. Additionally, because the total bycatch mortality of each species by all crab fisheries combined is estimated to be less than 2.5 percent of each stock's estimated abundance, it is assumed that the total effects of bycatch on stock abundance are insignificant.

Table 4.2-8 Bycatch mortality and abundance of snow crab in all crab fisheries in the Bering Sea, 1994- 2001.

Year	Bycatch Mortality	Abundance (millions of crab)	Bycatch mortality as a percent of abundance
1994	12,739,815	9,445.8	0.13%
1995	11,696,160	8,655.2	0.14%
1996	13,576,988	5,424.9	0.25%
1997	18,001,307	4,107.6	0.44%
1998	12,381,948	3,233.1	0.38%
1999	11,302,368	1,400.9	0.81%
2000	1,204,992	3,241.2	0.04%
2001	1,469,592	3,861.3	0.04%

Note: Values in numbers of crabs. Bycatch mortality rate of 24 percent applied to bycatch estimates of the target species.
Source: Abundance estimates from the 2002 AFSC Reports to Industry on the eastern Bering Sea Crab Survey (NMFS 2002).

Table 4.2-9 Bycatch mortality and abundance of red king crab in all crab fisheries in the Bristol Bay area, 1994- 2001.

Year	Bycatch Mortality	Abundance (millions of crab)	Bycatch as a percent of abundance
1994	1,488	33.9	0.004%
1995	0	33.9	0
1996	48,400	53.3	0.09%
1997	78,800	75.1	0.1%
1998	367,504	75.6	0.49%
1999	76,624	46.7	0.16%
2000	136,560	50.0	0.27%
2001	193,520	44.2	0.44%

Notes: Values in numbers of crabs. Bycatch mortality rate of 8 percent applied to bycatch estimates of the target species. The Bristol Bay red king crab fishery was closed in 1994 and 1995.
Source: Abundance estimates from the 2002 AFSC Reports to Industry on the eastern Bering Sea Crab Survey (NMFS 2002).

Table 4.2-10 Bycatch mortality and abundance of blue king crab in all crab fisheries in the St. Matthew area, 1994- 2001.

Year	Bycatch Mortality	Abundance (millions of crab)	Bycatch as a percent of abundance
1994	307,846	5.9	5.2%
1995	confidential	5.6	n/a
1996	128,027	10.0	1.28%
1997	confidential	10.0	n/a
1998	confidential	8.4	n/a
1999	n/a	1.7	n/a
2000	4,352	1.7	2.56%
2001	104	2.9	0%

Notes: Values in numbers of crabs. Bycatch mortality rate of 8 percent applied to bycatch estimates of the target species. The St. Matthew blue king crab fishery has been closed since 1999.
Source: Abundance estimates from the 2002 AFSC Reports to Industry on the eastern Bering Sea Crab Survey (NMFS 2002).

Table 4.2-11 Bycatch mortality and abundance of Tanner crab in all crab fisheries in the Bering Sea, 1994- 2001.

Year	Bycatch Mortality	Abundance (millions of crab)	Bycatch as a percent of abundance
1994	3,806,640	192.0	1.98%
1995	3,179,460	189.9	1.67%
1996	917,600	175.6	0.52%
1997	973,180	159.0	0.61%
1998	858,760	156.5	0.55%
1999	399,020	349.5	0.11%
2000	98,200	219.2	0.04%
2001	125,280	600.1	0.02%

Notes: Values in numbers of crabs. Bycatch mortality rate of 20 percent applied to bycatch estimates of the target species. The Bering Sea Tanner crab fishery has been closed since 1997.
Source: Abundance estimates from the 2002 AFSC Reports to Industry on the eastern Bering Sea Crab Survey (NMFS 2002).

Two other sources of unobserved crab mortality are catching mortality and direct gear impacts. Catching mortality is ascribed to those crabs that enter a pot and are eaten by other pot inhabitants before the pot is retrieved. Catching mortality likely occurs during the molting period, when crabs are more susceptible to cannibalism. Most crab fisheries are set to occur outside of the molting season, and catching mortality in these fisheries may be limited to octopus or large fish entering a pot. Because no evidence of crab or other species are left in the pot, these mortalities remain unassessed.

Another very minor source of human induced crab mortality is direct gear impacts. Direct gear impacts result from a pot landing on the ocean floor when it is being set, presumably damaging any crab on which it lands. With reasonable assumptions, direct gear impacts are only a very minor source of mortality. An estimate of this impact can be derived by multiplying the number of pot lifts, the area they occupy, and relative crab density within areas fished in the Bering Sea. Assuming that pots land on different areas after each lift, and crab pots are set non-randomly over areas with relatively high density of crabs in directed fisheries, the total number of crab impacted can be roughly estimated. For the 1993 red king crab fishery, assuming a density of 5,000 red king crab of all sizes per square mile (density data from Stevens et al. 1998), a maximum of about two thousand red king crab were impacted (NPFMC 1996). Similarly, a maximum of 9,000 Tanner crabs (assuming 10,000 crab/mile^2) and 110 thousand snow crabs (assuming 75,000 crab/mile^2) were impacted by direct gear impacts in respective crab fisheries in 1993. It is not known what proportion of these crab die when a crab pot lands on them.

Stock rebuilding

The terms overfishing and overfished mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the MSY on a continuing basis. In practice, however, a stock that is below the MSST as defined in the FMP is declared overfished, regardless of the conditions that resulted in a low stock level. Once NOAA Fisheries declares a stock overfished, the Magnuson-Stevens Act requires the Council to develop a rebuilding plan for that stock. For each rebuilding plan, the Council completed an EA to analyze the effects of alternative rebuilding plans on the human environment.

Four stocks in the BSAI are under rebuilding plans: St. Matthew blue king crab, Tanner crab, snow crab, and Pribilof Islands blue king crab. The Tanner crab fishery has been closed since 1997, the St. Matthew blue king crab fishery has been closed since 1999, and the Pribilof Islands king crab fishery has been closed since 1999. On September 24, 1999, NOAA Fisheries declared the St. Matthew blue king crab overfished because the stock was below the MSST of 11 million pounds. Within one year, the Council developed a rebuilding plan, as required by the Magnuson-Stevens Act. NOAA Fisheries approved the rebuilding plan on November 26, 2000 (65 FR 76175). On March 3, 1999, NOAA Fisheries declared Bering Sea Tanner crab overfished because the stock was below the MSST of 94.8 million pounds. The Council developed a rebuilding plan, which NOAA Fisheries approved on June 8, 2000 (65 FR 38216). On September 24, 1999, NOAA Fisheries declared Bering Sea snow crab overfished because the stock was below the MSST of 460.8 million pounds. The Council developed a rebuilding plan and NOAA Fisheries approved the rebuilding plan on December 28, 2000 (66 FR 742). NOAA Fisheries declared the Pribilof Islands blue king crab overfished on September 23, 2002 (67 FR 62212). The Council recommended a rebuilding plan for this fishery in October 2003, and it is under review by NOAA Fisheries.

Each rebuilding plan contains a rebuilding harvest strategy, bycatch control measures, and habitat protection measures. The rebuilding measures are described in Chapter 2 under Alternative 1. The rebuilding harvest strategies are the main components of these rebuilding plans and provide for the rebuilding of the stocks. Each rebuilding harvest strategy calculates the harvest rate based on stock abundance and closes the fishery when the stock is at low abundance, allows a reduced harvest rate at medium levels of abundance, and a slightly higher harvest rate when stock abundance is high. The bycatch control measures are pot gear modifications to provide escape mechanisms which reduce bycatch of sublegal and female crab in the directed crab fisheries. The most effective bycatch control measure is closing the fishery when stock abundance is below the threshold because the directed fishery is the single greatest source of bycatch of each crab species. For Tanner and snow crab, habitat protection measures include increased protection of these species' essential fish habitat from non-fishing activities. For St. Matthew blue king crab, the State closed the waters within three miles around St. Matthew, Hall, and Pinnacle Islands prohibiting all fishing to protect female spawning aggregations and their habitat. The rebuilding plan for the Pribilof Islands blue king crab does not contain additional habitat protection measures because blue king crab habitat in the Pribilof Islands is already protected by the Pribilof Islands Habitat Conservation Area.

Since the rebuilding plans were implemented, stock abundance for the four overfished stocks has fluctuated (Table 4.2-12). All four stocks are currently below their MSST. Snow crab had been above the MSST for two years, but declined below the MSST in the 2002 survey. Tanner crab, Pribilof blue king crab, and St. Matthews blue king crab have remained below the MSST. Pribilof Islands blue king crab continues to decline in abundance even after the fishery was closed in 1999.

Table 4.2-12 Abundance estimates, in millions of pounds, for stocks under rebuilding plans.

Stock	MSST	1999	2000	2001	2002
Snow	460.8	283.5	472.7	571	313.3
Tanner	94.8	70.1	59.1	67.7	69.4
Pribilof blue king	6.6	10	7.4	7	4.5
St. Matthews blue king	11	4.8	5.2	9	4.7

Notes: MSST - minimum stock size threshold.
Source: 2002 AFSC Reports to Industry on the Eastern Bering Sea Crab Survey (NMFS 2002).

Table 4.2-13 Guideline Harvest levels (GHLs), in millions of pounds, for stocks under rebuilding plans.

Stock	1999 GHL	2000 GHL	2001 GHL	2002 GHL	2003 GHL
Snow	186.2	26.4	25.3	28.5	23.6
Tanner	closed	closed	closed	closed	closed
Pribilof blue king	closed	closed	closed	closed	closed
St. Matthews blue king	closed	closed	closed	closed	closed

Notes: Guideline harvest levels do not include the allocation to CDQ groups.
Source: NPFMC's 2002 BSAI crab SAFE Report (NPFMC 2002).

As explained in Section 3.2 on crab life history, crab abundance is thought to be influenced by environmental factors, such as temperature and currents. This theory is supported by the fact that stock abundance fluctuates in the absence of fishing and non-target removals. For example, St. Matthews and Pribilof Islands blue king crab stocks have continued to decline even though the fisheries have been closed since 1999, these stocks are caught in nominal amounts as bycatch in other crab or ground fish fisheries, and their habitat is completely closed to fishing. Further description of the abundance trends and life history stages of these crab species is in Section 3.2.

Each alternative under consideration in this EIS would implement the existing rebuilding plans in the same manner. Under the rebuilding plans, the current fisheries for these species are closed unless abundance warrants a fishery at a reduced harvest level, such as for snow crab. Therefore, the rebuilding plans reduce crab mortality. It is assumed that by acting in a precautionary manner and reducing harvest and bycatch, and protecting habitat under these rebuilding plans, that the plans would have a beneficial effect on crab abundance over time.

Harvest methods

The methods of harvest include when the harvest occurs, the fishing effort, and how the crabs are handled. Harvest methods also include the extent to which fishermen comply with regulations. Harvest methods impact the crab resources by causing mortality of legal male crabs in excess of the harvest level and causing mortality of female, sublegal, and non-target crabs caught as bycatch.

Indicator: Handling mortality

In addition to the direct loss from retained catch, harvesting also reduces stock abundance due to bycatch mortality. Large numbers of crabs are handled and discarded during crab fisheries due to restrictions on size, sex, season, and target species. Handling mortality reduces future recruitment to the fishery by reducing both survival of prerecruits and effective spawning biomass due to deaths of mature females and sublegal males. Besides mortality, handling may also produce sublethal effects on crabs such as reduced growth (Kruse 1993). Impacts of handling mortality on stock abundance largely depend on handling mortality rates, which may vary considerably under different situations. Studies show that handling morality rates could be very low from the simulated fishing process (MacIntosh et al. 1996; Zhou and Shirley 1996) or very high from a laboratory study (Carls and O'Clair 1990, 1995; Kruse 1998) that considered extremely cold air temperatures during winter fisheries. An extensive bibliography of capture and handling effects was compiled by Murphy and Kruse (1995), and reviewed in some detail by Zheng et al. (1997b). Handling mortality rates are currently assumed to be 8 percent for king crabs and 20 percent for Tanner and 24 percent for snow crabs (NPFMC 2002), and a range of 0 percent to 50 percent were used for simulation studies (Zheng et al. 1997a, 1997b, 2002). Because catchability rates for females and sublegal males are much lower than those for legal males, a handling mortality rate of 20 percent or 25 percent results in a very low overall mortality rate for females and sublegal males from handling mortality under the current crab harvest strategies. Overall, although harvesting based on the current crab harvest strategies can reduce large male abundance considerably over time, the reduction of females by harvesting is small.

Several laboratory and field studies have been conducted to determine mortality caused by handling juvenile and female crab taken in crab fisheries. There are a variety of effects caused by handling, ranging from sublethal (reduced growth rates, molting probabilities, decreased visual acuity from bright lights, and decreased vigor) to lethal effects. Studies have shown a range of mortality due to handling based on gear type, species, molting stage, number of times handled, temperature, and exposure time (Murphy and Kruse 1995). Handling mortality may have contributed to the high mortality levels observed for Bristol Bay red king crab in the early 1980's (65 percent for males and 82 percent for females), that along with high harvest rates, resulted in stock collapse (Zheng et al. 1995b). However, another study concluded that handling mortality from deck and temperature impacts was not responsible for the decline of the red king crab fishery (Zhou and Shirley 1996).

Although estimates of injury rates have been made, attempts to measure direct or indirect mortality have met with little success. In studies of handling mortality, Tanner crabs were subjected to dropping, artificially induced injuries, and multiple pot recoveries, but subsequent mortality was low and not significantly greater than controls (MacIntosh et al. 1996). Red king crabs were also subjected to multiple simulations of actual handling, with no significant effects on mortality (Zhou 1995). There is probably some mortality associated with injury and discards, but it has not yet been adequately determined. Freezing due to windchill causes significant mortality of snow crabs (Warrenchuck and Shirley 2002), king crabs, and Tanner crabs (Carls 1989). Median lethal exposures were -16°C for king crabs, and -2.2°C for Tanner crabs. Vigor (measured by righting time), feeding rates, and growth at subsequent molting were all significantly reduced. About 11 percent of Tanner crabs lost legs due to autotomy at extreme temperatures, and some king crabs lost legs or died at subsequent molts. There was no apparent effect on larval hatching of female king crabs that survived windchill exposures (Carls 1989). However, little is known about the actual temperature conditions affecting crabs in real fisheries.

Byersdorfer and Watson (1992 and 1993) examined red king crab and Tanner crab taken as bycatch during the 1991 and 1992 red king crab test fisheries. Instantaneous handling mortality of red king crab was <1 percent in 1991, and 11.2 percent in 1992. Stevens and MacIntosh (1993) found average overall mortality of 5.2 percent for red king crab and 11 percent for Tanner crab on one commercial crab vessel. Authors recommend these results be viewed with caution, noting that experimental conditions were conservative. Mortality for red king crab held 48 hours was 8 percent (Stevens and MacIntosh 1993, as cited in Queirolo et al. 1995). A laboratory study that examined the effects of multiple handling indicated that mortality of discarded red king crabs was negligible (2 percent), although body damage increased with handling (Zhou and Shirley 1996).

Delayed mortality due to handling does not appear to be influenced by method of release. In an experiment done during a test fishery, red king crab thrown off the deck while the vessel was moving versus those gently placed back into the ocean showed no differences in tag return rates (Watson and Pengilly 1994). The effects of handling methods on mortality have been shown to be in minor laboratory experiments with red king crab (Zhou and Shirley 1996) and Tanner crab (MacIntosh et al. 1996). Although handling did not cause mortality, injury rates were directly related to the number of times handled.

Mortality of crabs is also related to time out of water and air temperature. A study of red king crabs and Tanner crabs found that crabs exposed to air exhibited reduced vigor and righting times, feeding rates (Tanner crabs), and growth (red king crabs) (Carls 1989). For surviving females, there was no impact on survival of eggs or larvae. Cold air resulted in leg loss or immediate mortality for Tanner crabs, whereas red king crabs exhibited delayed mortality that occurred during molting. A relationship was developed to predict mortality as the product of temperature and duration of exposure (measured as degree hours). Median lethal exposure was -8°C for red king crab and -4.3°C for Tanner crab. For example, if crabs were held on deck for 10 minutes and it was -23°C (-10°F) outside, about 15 percent of the king crab and 50 percent of the Tanner crab would die from exposure. Because BSAI crab fisheries occur from November through March, cold exposure could cause significant handling mortality to crabs not immediately returned to the ocean. Zhou and Shirley (1996) observed that average time on deck was generally 2 to 3 minutes, and they concluded that handling mortality was not a significant source of mortality.

Further research has indicated that windchill may be an important mortality factor. In 1997, a laboratory study examined the effects of cold windchill temperature on mortality, limb loss, and activity (righting response) for sublegal sized male Tanner crabs (Zhou and Kruse 1998; Shirley 1998). The study found significant inverse relationships between windchill and crab mortality, limb loss, and activity. Crabs were exposed to combinations of temperatures and wind speeds for a duration of 5 minutes, then placed in seawater tanks and held for 7 days. Zhou and Kruse (1998) found that virtually all crabs died when exposed to windspeeds greater than 7.7 m/s (15 nautical miles per hour) and air temperatures less than -10.4°C (13.3°F). Stronger winds, even at warmer temperatures (but still below freezing), can have the same effect. Shirley (1998) estimated that 50 percent of the crabs would die in windchill temperatures of -11°C (this windchill temperature can result from air temperatures of 21°F and wind speeds of 30 nautical miles per hour). Shirley (1998) concluded that "the effects of windchill on sublegal Tanner crabs is dramatic, and undoubtedly results in decreased recruitment to adult stocks. Management steps should be taken to restrict exposure of discarded crabs to debilitating windchill by regulating aerial exposure (sorting within water tables) or by regulating fishing effort during periods of extreme windchill."

The effects of windchill on snow crabs have not been directly studied. It would be expected for retained legal snow crabs to show similar effects due to windchill as Tanner crabs, due to the size and morphological similarity of snow and Tanner crabs. However, there is evidence from the snow crab fishery that windchill during handling may not be as important a mortality factor as would be expected from the laboratory study on Tanner crabs (Shirley 1998) and prevailing weather conditions. The primary evidence in this regard is the low rate of deadloss that occurs during the snow crab fishery. The snow crabs that are delivered to processors are subjected to the same windchill exposures before being sorted on deck and deposited into the holding tank as are non-legal snow crabs and Tanner crabs before they are sorted and discarded. Data collected by onboard observers during the 1999 snow crab fishery indicate that bycatch crabs generally are not exposed to the air any longer than the retained catch.

Because snow crabs are typically kept in holding tanks for one to three weeks prior to offloading at processors, high rates of deadloss would be expected in the deliveries if on-deck windchill exposure resulted in mortality rates comparable to those experienced by Tanner crabs in the laboratory study. Commercial catch statistics from the 1990 through 1998 snow crab seasons, however, indicate that the annual deadloss averaged only 1.3 percent of the total delivered snow crabs, and ranged from 0.7 percent to 2 percent. Such low rates of deadloss, despite the low temperatures and high winds that can occur in the Bering Sea during the snow crab fishery, may be reflective of features of fishing vessels and fishing practices that serve to protect captured and sorted crabs from windchill exposure. Shelter decks, storm walls, use of totes, and leeward alignment of vessels during gear retrieval, for example, would all tend to protect crabs from windchill exposure during sorting. Additionally, observer data collected during the 1998 and 1999 snow crab seasons indicate that sorted bycatch typically is returned to the sea in less time than the 5 minutes that crabs were exposed to windchill during the laboratory study. Data on limb autotomies collected from bycatch Tanner crabs by onboard observers during the 1999 snow crab season also indicate that the effects of windchill in practice is less than that predicted from laboratory studies and prevailing weather. Examination of 1,718 bycaught Tanner crab prior to discarding during the 1999 season indicates a limb autotomy rate of only 0.3 percent, well below the limb autotomy rates seen in the laboratory study for windchill associated with high mortality rates. In summary, although it has been conclusively shown that windchill can effect high rates of mortality in Tanner crabs, there is also evidence that exposure of captured crabs to such windchill may not be common during actual fishing.

Despite the research on handling mortality, we do not have a good understanding of the effects of handling on crab bycatch mortality. The effects of handling mortality are directly related to how many crabs are handled, which is the amount of bycatch, and how the crabs are handled on deck before being released to the water. Because the effect of bycatch on stock abundance is insignificant, it can be concluded that the effects of handling mortality on crab abundance are insignificant. However, crab handling methods could be improved to further reduce handling mortality.

Indicator: Harvest effort

Harvest effort is the amount of vessels and gear deployed to catch the harvest limit. The amount of effort deployed in each crab fishery is detailed in Section 3.4.3. Harvest effort above the amount required to catch the harvest limit results in harvests above the limits, increased bycatch, and increased habitat impacts, which negatively effect the crab stocks. Excessive harvest effort also causes wasteful fishing practices and results in the fleet deploying more pots than could be retrieved during a short fishing season, which results in lost pots. These problems increase the impacts of fisheries on the crab stocks.

Crab abundance is cyclical and fishing effort in the crab fisheries had increased during times of higher abundance and higher prices. The current derby style fishery also encourages excess harvest capacity as fishermen boost their capacity to increase their rate of harvest. The overall trend in participation has decreased for several years because of a number of factors, which include the depressed nature of many crab stocks and the resultant low GHLs, lower ex-vessel values paid for crab because of current market conditions involving Asian exchange rates, and increased fuel and insurance costs to participants. Many vessels still participate because they are speculating they will receive harvest privileges in a future rationalization program. Participation would be expected to continue near current levels under the status quo, and the effect on the crab resources should not change. One important variable in the participation of vessels is the general economic stability of the crab fisheries. If it is assumed that supply and demand crab markets remain approximately similar to recent years, and that the fishery is approaching a fully exploited state with respect to inputs, the number of fishermen participating in these fisheries may not fluctuate significantly if fishing seasons remained consistent with past patterns. In the Bristol Bay red king crab fishery, approximately 255 vessels participate each year (average number of vessels for the last ten fishing seasons). Approximately 100 vessels participate in the St. Matthew blue king crab fishery, and approximately 65 vessels fished the Pribilof Islands fishery. For Tanner crab, approximately 200 boats participated in harvesting Tanner crab, and over 240 on average take part in the snow crab fishery. Note that these numbers represent average participation.

Under status quo, the race for fish and resulting excess capacity has resulted in management measures that aim to limit harvest effort. The LLP and the Norton Sound super-exclusive registration area are the two Category 1 measures that restrain capacity in the BSAI crab fisheries. The LLP limits the total number of vessels that can participate in the BSAI crab fisheries. The LLP also restricts the length of the vessel to be deployed under the license to a MLOA. The Norton Sound super-exclusive registration area restricts access to the Norton Sound red king crab fishery to those vessels that fish it exclusively. This measure protects the Norton Sound small boat fleet from competition with the larger vessels from the rest of the BSAI crab fisheries. These measures have been effective at restraining capacity to some extent, however, they do not reduce capacity to the levels necessary for efficiency and they do not end the race for fish among the remaining participants.

The Category 2 measure that limits the harvest effort is the pot limits set by the State. Pot limits restrict the amount of gear each vessel can deploy to reduce gear loss. Lost gear performs ghost fishing, which is when the pots continue to catch and kill crab until the pot degrades. However, pot limits have resulted in economic inefficiencies in the fleet and decreased the amount of soak time per pot.

Despite these measures to limit harvest effort, the harvest effort is still above the amount required to harvest the GHL. Excess effort in the crab fisheries under status quo impacts crab stocks and results in shorter seasons. During short seasons, with the race for fish, fishermen cannot be as selective of fishing locations as they could be under a slower paced fishery, resulting in more female and sublegal male crab bycatch. The excess harvest effort in the crab fisheries is one of the reasons the Council is considering rationalization programs for these fisheries. However, given the conservative harvest levels and short seasons, it appears that the current level of harvest effort has an insignificant effect on crab abundance.

Indicator: Manageability of fisheries

Since the goal of most management measures is conservation, the increased ability of managers to ensure compliance with harvest limits and other regulations has stock conservation benefits. Manageability of fisheries is directly related to the harvest effort and encompasses many of the other issues discussed in this section, such as overharvest of the GHL. Harvest effort in excess of the amount of effort necessary to harvest the harvest level decreases the manageability of the fisheries. Monitoring provides information to managers on the amount of catch and bycatch, and the location of harvest. This information is vital for setting the harvest levels, measuring the effectiveness of bycatch reduction measures, and determining when each vessel has reached its quota. Data collection is important for establishing the scientific foundation on which the fishery is managed. Improved manageability of the fisheries would have positive effects on stock abundance. Probable effects of Alternative 1 on the crab stocks can be estimated based on the manageability of the fishery and the extent of monitoring.

The current conditions in the BSAI crab fisheries creates difficulties in managing these fisheries. Managers make decisions to close the fisheries based on incomplete information. In order to estimate the amount of harvest taken by the fishery during the season, managers rely on voluntary reporting from participating vessels. From these reports, managers determine when the fishery should be closed by estimating when the fleet would harvest the GHL. The fleet is provided 24 hour notice that the fishery will close at a specific time. Actual harvests are not known until a week or two after the fishery closes when processors report the amount of crab landed in production reports. This system results in actual harvests either above or below the GHL.

This management difficulty can be detrimental to stocks at low abundance levels. Fisheries with small GHLs and a large number of participants are difficult to manage because the fleet can harvest way over the GHL before managers could close the fishery. To avoid over harvesting small stocks, the State sets a minimum GHL below which the fishery will not open. Harvesting above a maximum GHL when a stock is at very low levels of abundance can negatively impact stock abundance.

The fisheries are partially monitored in-season by the observer program and post season information is collected by the processors through the fish ticket system. From this information, managers determine the actual harvest, the amount of bycatch of the observed fleet (10 percent for the Bristol Bay red king crab, snow crab, St. Matthews and Pribilof Islands king crab, and Tanner crab fisheries, and 100 percent in all other BSAI crab fisheries), and the location of fishing activity by statistical area. ADF&G has determined this level of monitoring is sufficient for managing the BSAI crab fisheries. However, the level of detail of the information could be improved by increased observer coverage, real-time reporting, and monitoring the exact location of the vessels.

Managers have implemented measures to improve the manageability of the BSAI crab fisheries. The LLP reduces the number of participating vessels. Pot limits constrain the amount of gear deployed. Minimum GHLs eliminate fishing on small stocks when a fishery would be unmanageable. These measures have improved the manageability of these fisheries, however, they have not addressed the fundamental problem of overcapacity. Additional improvements in the manageability of these fisheries requires comprehensive measures to reduce the race for fish and reduce overcapacity. However, given the management difficulties of Alternative 1, the effects of these difficulties on the abundance of BSAI crab is insignificant.

Reproductive success

Reproductive success is due to a combination of factors, many of which are not fully understood by scientists. Fishing pressure can influence a stock's reproductive success. The indicators for this issue include three ways that fisheries may impact a stock's reproductive success; change in ratio of males to females, decrease in the size of male crabs, and genetic diversity. NOAA Fisheries annual trawl survey data is used to measure the ratio of males to females and the size distribution of large male crabs over time.

Impacts of harvesting on future recruitment mainly depend on crab reproductive biology and spawner-recruit (S–R) relationships. Current crab harvest strategies allow retaining only legal males. On one hand, mature, sublegal males are allowed one or two years of mating before reaching legal size. On the other hand, harvesting only large, legal males disproportionally reduces large male abundance. Genetic effects of reducing large male abundance on the population are currently unknown. Research on snow crabs indicates that new shell males may not take part in mating (Saint Marie et. al.1999 and Saint Marie et. al. 2002). This may mean that males that molt to maturity and to a retainable size may not mate at all before being caught in the fishery. Mating of crabs is complex and its success depends on the distribution, sex ratio, and size difference between mature female and male crabs. In confined environments, large, legal-sized male crabs are capable of mating with more than seven female crabs successfully during a breeding season (Paul 1984). Sex ratios of mature females to legal-sized males of surveyed crab stocks in the eastern Bering Sea are generally much lower than seven. However, in natural environments, some mature females may not be able to find mates if no mature males are nearby. No data have been consistently collected over time to accurately measure crab mating success/failure in the eastern Bering Sea. Egg conditions and clutch size data, which may provide some information on mating success/failure, have been collected for major crab stocks in the eastern Bering Sea. However, clutch sizes and maturity depend on time of year when measurements were taken. Variability in the timing of surveys can impact the estimate of mean clutch fullness (Otto et al. 1989). Therefore, caution is needed to interpret the clutch fullness data. Overall, although recent crab mature harvest rates are lower than those in the past, no clear trends of mean clutch fullness were observed for eastern Bering Sea crab stocks.

Due to difficulty in ageing crabs and complex crab reproductive biology and behaviors, developing S–R relationships for crab stocks is challenging. So far, S–R relationships have been developed for only four stocks in the eastern Bering Sea: Bristol Bay red king crabs, Bristol Bay Tanner crabs, eastern Bering Sea snow crabs, and Pribilof Islands blue king crabs (Zheng and Kruse *in press*). The estimated S–R relationships varied with species. For red king crabs, weak recruitment was associated with extremely small spawning biomass and strong recruitment was associated with intermediate spawning biomass, suggesting possible density-dependent effects. However, the king crab recruitment trends were also consistent with patterns of decadal climate shifts. Results were equivocal. For Tanner crabs, the autocorrelated Ricker model fit the data much better than the general model, and most of the variability of Tanner crab recruitment can be explained by a cycle period of 13-14 years. No clear S–R relationships are observed for blue king crabs and snow crabs. Overall, the association between recruitment and spawning biomass for eastern Bering Sea crab stocks appears to be weak; spawning biomass explained very little recruitment variation for most stocks.

Weak density-dependent S–R relationships for crab stocks result in a weak feedback from harvest control to future recruitment. Based on these S–R relationships, the current harvest strategies have little influence on the future recruitment for most crab stocks except when the population abundance is very low. The thresholds and low harvest rates in the current harvest strategies are designed to avoid negative impacts of harvesting on the future recruitment when the population abundance is low.

4.2.2.2 Alternative 2

This section, prepared by ADF&G, addresses the effects of Alternative 2, the three-pie voluntary cooperative, on crab stocks. Specifically, the section is intended to describe how this alternative may affect important issues identified in the scoping process for the EIS, such as any change in female or sub-legal male mortality. While it is desirable to evaluate the significance of these identified effects, it is technically difficult to do this with existing data. Ideally, the analyst would carry out the significance analysis by contrasting known sources of fishing mortality with known sources of mortality from the marine environment. This would be achieved by putting probable management actions into the context of the influences of the marine environment and the naturally occurring population dynamics of Bering Sea crab. However, due to the lack of quantifiable data, we can offer some very general comments regarding the significance of the preferred alternative.

King and Tanner crab stocks exhibit high amplitude variation in stock abundance over time due largely to wide variation in annual recruitment. The wide variation in annual recruitment that has been observed over the history of the fisheries is generally believed to reflect the effects of the physical and biological environment. Nonetheless, it has been demonstrated that the abundance of mature animals has at least some effect on future recruitment; for all stocks it is known that mature animal abundance must have an effect on future recruitment at some critical lower level of abundance. Hence, fishery management practices have been developed under the Board's Policy on King and Tanner Crab Resource Management Goal and Benefits with the intent of minimizing irreversible adverse fishery effects on future stock recruitment and allowing for rebuilding of depressed stocks by: maintaining multiple size and year classes of mature animals; lowering harvest rates with decreases in mature stock abundance; setting minimum stock threshold levels for fishery openings; and minimizing handling and mortality to females, undersized males, and other non-target animals. Changes in fishing practices under rationalization could facilitate implementation of such practices in many cases, while in other cases it could make implementation more difficult. In any case, State management measures under a three-pie voluntary cooperative would continue to be guided by the board's policy for king and Tanner crab and would adjust accordingly to any changes in fishing practices resulting from the program. However, management actions taken to maintain and rebuild stocks would have a small impact relative to the overriding role of environmental influences on stock levels and recruitment.

This section also summarizes the actions that were taken, or need to be taken, by the State, the Council, and NOAA Fisheries in addressing the relevant issues raised in the EIS scoping process for BSAI crab rationalization. These relevant issues are concerns brought forward by the public during the scoping process and/or identified in the Council's problem statement. The issues, presented in Table 4.2-14, have associated indicators that describe the potential impact of the preferred alternative. Table 4.2-14 then describes the action or management tool that the appropriate managing entity would adopt or consider adopting, within the scope of the FMP to address the relevant issues within the context of crab rationalization.

The FMP has adopted a management hierarchy that delegates certain management authorities for the Council and NOAA Fisheries (such as limited access management), the BOF, and ADF&G. Coordination between these entities is required to attain balance that achieves management goals and maximizes the conservation of the resource. Additionally this delegation of management responsibility provides the economic and social benefits envisioned in the rationalization program alternatives. A combination of both the federal action adopting this program and actions by the BOF to change its regulations would provide a coordinated effort to address conservation issues.

Table 4.2-14 Effects of Alternative 2 on relevant issues.

Issue	Indicator	State Actions	Federal Actions
Fishery sources of legal male crab mortality	Indicator 1a - Harvest above the GHL	Adopt TAC management	Adopt IFQ program with TAC management - to slow fishery and improve enforcement.
	Indicator 1b - Highgrading	Set maximum/minimum escape mechanisms in pots Review observer program Review harvest strategies	Adopt IFQ program - to slow fishery to allow individual or collective fishing to improve fishery targeting on high quality crab.
	Indicator 1c - Deadloss	Review regulations on retention of landed crab Adopt TAC approach	Adopt IFQ program - to slow fishery and improve enforcement. Adopt cooperatives - to coordinate harvests and landings.
Fishery sources of female and sublegal crab mortality	Indicator 2a - Amount of bycatch	Review observer program Consider inseason area management closures	Adopt IFQ program - to slow fishery and improve enforcement. Adopt cooperatives - to coordinate fishing activity.
Stock rebuilding	Indicator 3a - Abundance of overfished stocks	Review harvest strategies and rebuilding plans	Adopt TAC management - to eliminate harvest overages. Adopt IFQ management - for individual accountability.
Fishery sources of non-target crab mortality	Indicator 4a - Amount of bycatch of non-target crabs	Allow multispecies retention for IFQ holders Adopt TAC management	Adopt IFQ management - to slow fishery and allow pots to sort. Adopt cooperatives to further rationalize the fishery activity.
Harvest methods	Indicator 5a - Handling of crab	Expand fishing seasons within biological period Increase pot limits so they soak and sort	Adopt IFQ management to slow fishery and allow pots to sort crab in the water, increase stewardship with captain shares, and provide economic returns that allow fishermen to pick weather conditions that promote better handling.
	Indicator 5b - Harvest effort	Increase pot limits so they soak and sort	Adopt IFQ management to reduce capacity. Adopt cooperatives to further reduce capacity.
	Indicator 5c - Manageability of fisheries	Board adopts complementary regulation to Council program	Council adoption of crab rationalization program.
Other bycatch species (not crab)	Indicator 6a - Amount of non-crab bycatch	Review observer program Area closures Expand fishing seasons	Adopt IFQ program to stop the race for fish and allow fishermen to move away from non crab fishermen & avoid gear conflict. Adopt cooperatives to further coordinate fishing activities.
Habitat impacts	Indicator 7a - Area impacted and habitat type impacted	Review observer program Close waters	Rationalize fishery to achieve consolidation, slow the pace of the fishery and focus fishermen on the most productive target species harvest areas.

Alternative 2 proposes changes to Category 1 elements that would address these relevant issues. Section 4.1.1 explains that the BOF may adopt or change a number of regulations under Category 2 or 3 management measures that similarly address these issues. The BOF, or the Secretary of Commerce, could adopt or change regulations (management tools) to address the impacts on the relevant biological issues. The following discussion provides insight as to how the coordination laid out in Table 4.2-14 can be expected to work.

Fishery sources of legal male crab mortality

This issue has three indicators: 1) harvest above GHL, 2) highgrading, and 3) deadloss. The preferred alternative contains an IFQ program with voluntary cooperatives to slow the pace of the fishery, coordinate harvests and landings, and improve monitoring and enforcement.

Harvest Strategies and Overfishing Definitions: Rationalization of the crab fisheries will result in changes to fishing strategies, areas fished, time of year when fishing occurs, and bycatch of male and female crab. Harvest strategies incorporate bycatch in determination of optimum harvest rates, hence those rates may change due to changes in bycatch. Overfishing definitions also need to account for bycatch, time of year when fishing occurs and areas fished. Rationalization may result in increased fishery pot soak times and highgrading. Bycatch rates of sublegal males and females may decrease from longer soak times, however total bycatch (including sublegal males, females, and commercial size males) may increase from more pot lifts per retained crab due to highgrading. Highgrading would result in discards of commercial size crabs of lesser market value, e.g., old shell crab and crab with missing limbs. At this time it is not known whether total bycatch will increase or decrease under rationalization, however, the composition of the bycatch will most likely change. Harvest strategies will need to be reevaluated to account for the changes in total catch. Length composition, sex and shell condition of bycatch will need to be accounted for in harvest strategies and may result in changes to target exploitation rates. Overfishing definitions are currently being revised and will depend on the composition of bycatch as well as retained catch. At this time, it is not known whether exploitation rates will increase or decrease under rationalization. Bycatch from observer data under rationalization will need to be analyzed and used in harvest strategy simulations to make those determinations.

Minimum GHLs have been established for in-season manageability of crab fisheries. If the estimated GHL is below the minimum GHL, then the fishery is closed. Harvest strategies incorporate biomass based thresholds, below which the fishery is closed, that are different from the minimum GHLs for in-season manageability of the fishery. Due to the short time current fisheries have been open, the retained catch would exceed the GHL before the fishery could be closed if the GHL was set below the minimum GHL. Under rationalization there would be no need for this type of minimum GHL since each vessel or cooperative would have a fixed quota. The minimum GHL under rationalization would then depend on the biomass based thresholds, which would be determined by the harvest strategy. This may allow fisheries to be open with lower GHLs than without rationalization as in general the minimum GHLs have been above the GHLs that would result at the biomass based thresholds. Current harvest strategies incorporate the minimum GHLs for manageability of the fishery, therefore would need to be reevaluated without them.

Harvest above GHL: Under an IFQ program, each fisherman has a certain amount that they are allowed to catch and retain. This prevents harvest above the GHL, with proper catch accounting and penalties for overages, because each fisherman is constrained to harvest their IFQ. It additionally proposes a change to the FMP that allows the State to move from GHL to TAC management. As noted in Section 4.1.1, TAC management may also provide a more enforceable tool that assures the season's allowable catch would not be exceeded. The State's actions would include adoption of TAC accounting of both live and dead crab and review regulations on retention of landed crab.

Under status quo, each fishery has a minimum GHL for fishery opening to maintain the ability to manage the fishery inseason. If the calculated GHL is below the minimum GHL, then the fishery is not opened. The minimum GHL prevents a large number of vessels from greatly exceeding a small fishery's GHL before managers can close the fishery. Under alternative 2, a minimum GHL may not be necessary because the harvest amount would not exceed the quota allocation. Additionally, with a small quota, fishermen may transfer quota so that only a small number of vessels harvest the TAC. Removing the minimum GHL would result in allowing fishing to continue at lower stock sizes than under status quo.

Highgrading: Highgrading is the discarding of legal male crabs that do not meet quality specifications, such as shell condition and size. Highgrading may occur under a rationalized fishery if the incentives exist for fishermen to discard a portion of legal males and continue to fish for higher quality crab. Highgrading can have negative consequences to stock health. Highgrading is a resource concern because it may alter the composition of the stock by removing only the largest, cleanest crab. The largest crab are also thought to be the most successful at mating. With the slowing down of the fishery comes the opportunity to target on larger and better quality crab. This results in highgrading activity on older, more robust crab. State management tools to address this would include reviewing the observer program to consider whether the current coverage level is adequate to assess fishery changes, reviewing current harvest strategies adopted by the BOF, and a review of harvest patterns if there is a need to impose gear changes such as setting maximum and minimum escape mechanisms within pots.

In a rationalized crab fishery, the incidence of highgrading of larger, cleaner, more desirable, and more valuable crab may increase as fishermen have longer seasons and more time to fish in a manner that increases economic return on their limited IFQ. Under open access, at reduced GHL, every legal marketable crab that comes on board is kept. A vessel may move to a different area, but once landed, legal crab will be kept unless it is absolutely unmarketable. Market forces could provide incentives for selective harvest of larger size or shell classes that could occur with changes in fishing practices facilitated by rationalization. The Russian red king crab fishery provides an example of fishery selectivity in response to market forces resulting in detrimental effects to a crab stock and fishery. Pricing-by-size is common in Russia, with the highest price paid for the largest and oldest king crab. Russian quota holders maximize the value of their quota by a combination of poaching and highgrading. Unfortunately, this has resulted in the Russian stock size distribution collapsing and stock failure. There is anecdotal evidence of on deck sorting or highgrading to some degree in the Russian zone. Quotas combined with long seasons allowed sorting for a higher value product. This, combined with poaching, resulted in the average sizes for Russian red king crab dropping and smaller sized crabs entering the market. This reduced size distribution occurred within five years and is believed to be a contributing factor to lower fecundity and stock failures in Russian waters. The reduced size distribution of residual, unharvested crabs may impact long-term reproductive potential and stock genetics. Recent research indicates that larger, older mature males play a more important role in reproduction than smaller mature males, with growth rates and male size of maturity likely having a genetic component.

Some small level of highgrading has been observed in CDQ crab fisheries which operate in a rationalized manner, but this is not widespread. If highgrading appears to be a problem, the BOF could take action to halt or diminish this practice. The best tool to deal with this would be reevaluation of current harvest strategies. It is the policy of the BOF to:

> "maintain crab comprised of various size and age classes of mature animals in order to maintain long term reproductive viability of the stock and reduce industry dependence on annual recruitment, which is extremely variable." (90-04 FB March 23, 1990)

ADF&G harvest strategies currently address that policy by setting caps on the harvest rate of the size-shell component of legal males that is selected for retention in the fishery. In the king crab fisheries, where there is currently little evidence for strong fishery selectivity within the class of legal-sized males, the harvest rate cap is applied to the preseason abundance of legal-sized males. In both the Bering Sea Tanner crab and snow crab fisheries, however, there is strong selectivity by the fishery for legal males in new-shelled (clean-shelled) condition as opposed to old-shell (dirty-shell) condition. In the Bering Sea snow crab fishery, processor standards for delivered crabs also results in strong selectivity for males with greater than or equal to 4-inches CW, although the legal size is 3.1-inches CW. Accordingly, the harvest strategies for the Bering Sea snow crab and Tanner crab fisheries apply the harvest rate cap to exploitable legal males, which is a subset of the legal males defined on the basis of fishery selectivity for shell condition, size, or both. Again, harvest strategies developed for Bering Sea king and Tanner crab stocks since the mid-1990's account for assumed bycatch and handling mortality of non-retained crabs in the determination of the harvest rate on mature- or legal-sized males. Other options the BOF may take to address highgrading might include adopting a minimum/maximum mesh size escape panel, ring and tunnel entrance openings to prevent highgrading on the bottom and still allow female and sub-legal crab to escape, time-area closures, increased observer requirements or, less desirable, mandatory retention of all legal animals up to individual or cooperative-pooled quota share limits. Full retention may not be enforceable, and could be counter-productive by lowering long-term fishery value and by increasing deadloss in the tank due to the spread of disease through retention of legal crabs in poor condition.

Sorting on the bottom with longer soak times could have similar detrimental consequences if the escape panel mesh size were enlarged above the current regulatory minimum. Only larger crab would be retained (i.e., gear selectivity). If, however, the mesh size were not allowed to exceed the current size and soak times were to increase (probably adjusting or eliminating pot limits) then sorting on the bottom should prove to be an important conservation benefit of rationalization. Small males and females would escape prior to pot retrieval. Thus, the BOF may consider adopting a minimum/maximum legal size and work with panel, ring and pot mouth openings to achieve these ends. Otherwise, the fleet is likely to get the same market signal that the Russian crab fleet received.

Deadloss: Deadloss is an indicator of poor handling and is expected to decrease under the rationalization program proposed by the Council. This decrease should occur because the fishery pace is slowed for individual IFQ fishermen and there would be coordinated harvests and landings under voluntary cooperatives. The slower fishery and the federal IFQ regulations could also enhance enforcement through more thorough landings observations and penalties for not reporting deadloss crab. The State's actions would include adoption of TAC accounting of both live and dead crab and review regulations on reporting of deadloss crab. Because such regulations may not be enforceable, the BOF would have to consider their value.

Bycatch

Bycatch in the crab fisheries is predominantly female and small male crabs of the target species and other crab species. All bycatch is discarded at sea. In general, bycatch should decrease under Alternative 2 due to changes in fishing practices and increased monitoring. As decrease in bycatch of female and sublegal male crabs of the target species would reduce the total fishery mortality. To reduce discards of non-target crab, State regulations could be considered to provide for multispecies retention for quota share holders or voluntary cooperative members.

Alternative 2 would slow the individual fisherman's harvest pace and better allow the pots to sort crab on the bottom. This in turn results in (a) longer pot soak times to sort out unwanted catch on the bottom; (b) less crowding in areas of high crab productivity; and (c) ability to avoid marginal grounds where unwanted bycatch is often found, and (d) improve handling of crab of deck. The State would consider expanding the harvest season within the biological seasons to improve harvest of target species and reduce bycatch. With the slowing down of the fishery comes the opportunity to let the pots soak longer on the bottom, which results in more selective catches of legal males and greater escape of sublegal males and females. Longer seasons and relaxed pot limits would allow required crab pot escape mechanisms to more effectively sort on bottom. Given this opportunity, it is assumed the fishermen would soak pots longer to maximize the retained catch per pot pull and reduce bycatch. Fishermen want to avoid bycatch because, besides being wasteful, bycatch means sorting on deck, which takes time away from pulling pots. Research has shown that longer soak times result in more sorting by the gear's escape mechanisms. With more soaking time, the more time the smaller female crab have to escape from the pot. The same holds true for sublegal male crab. However, if pots soak too long, then mortality may actually increase due to predation by octopi and amphipods. Fishermen will need to determine optimal soak time long enough to allow females and sublegal males to escape but not so long that the crabs in the pot suffer from predation.

Some information on the changes in soak times under a rationalized fishery can be obtained from comparing the CDQ fisheries to the regular commercial fisheries under status quo. In general, the CDQ fisheries, which are rationalized, have longer soak times that the regular commercial fisheries (ADF&G 2003).

Formation of voluntary cooperatives can further reduce these impacts as members fish cooperatively and help fellow members stay away from areas of high bycatch. Increased season lengths, if adopted by the BOF, would allow fishermen the opportunity and time necessary to search for fishing grounds with lower concentrations of bycatch. This is possible because most stocks tend to segregate geographically by size and sex. Female and small male crab could be better avoided. Additionally, fishermen could exchange instantaneous information about catch rate and mix of harvest. If one member of the cooperative experiences high catches of females and sublegal males, the rest of the vessels in the cooperative would be alerted to avoid the area of high bycatch. Additionally, state managers monitoring a slower paced fishery, would be in a better position to issue timely in-season area closures to move fishermen out of areas of high bycatch.

Handling mortality of bycatch is expected to decrease as handling practice improve with longer fishing seasons and the end of the derby fisheries. Old-shell crab, which may be an important reproductive component in the population, females, and sublegal males could be sorted quickly and returned unharmed. Handling mortality is discussed in more detail below in this section.

Harvest strategies developed for Bering Sea king and Tanner crab stocks since the mid-1990's account for assumed bycatch and handling mortality of non-retained crabs in the determination of the harvest rate on mature or legal-sized males. Under alternative 2, the harvest strategies would continue to account for assumed bycatch and handling mortality in establishing the TAC for legal males. However, these may be adjusted if bycatch impacts can be determined to have diminished or increased under the rationalized fishery. A decrease in discards would decrease the total fishery mortality relative to the TAC. As a result, managers may adjust harvest strategies to allow for greater directed harvests. Conversely, if discards increase due to highgrading, then the total fishing mortality would increase relative to the TAC and managers would likely adjust harvest strategies to reduce directed harvest limits to account for the harvest of a smaller segment of the population. Additionally, the imposition of TACs would reduce bycatch by curtailing fishing once the harvest quota is taken.

Information on the amount of females and sublegal males caught as bycatch is gathered by on-board observers. This information is then used by managers to assess the total fishery removals and to estimate the effects of the fishery on stock abundance. The BOF would also review existing observer coverage levels to determine if these levels should be adjusted in any manner to scientifically determine changing bycatch levels. Increased monitoring would provide more explicit estimates of total fishing mortality, which would improve the information used in the TAC setting process, resulting in more accurate TAC levels.

Rebuilding depressed stocks

Stock rebuilding is an issue of concern when stocks are at depressed levels. The change of fishing practices in a rationalized fishery could affect the outcome of rebuilding programs in the BSAI fisheries. Rebuilding programs are developed when NMFS declares a stock "overfished." The abundance of overfished stocks would be an indication of whether or not the rationalization program is having a positive or negative affect on stock rebuilding. While the current understanding of crab biology suggests that environmental conditions are the single most important components driving recruitment failure, conservative management is needed to assure that the spawning biomass is sufficient to produce rebuilding when environmental conditions are favorable. If rationalized fisheries have less bycatch and can stay within their QS limit, this will be beneficial to rebuilding. Because a co-op or IFQ fisherman fishes an exact, pre-specified quota, which they may not lawfully exceed, the management target should rarely, if ever, be exceeded. Management precision would be greatly increased, which should aid in stock rebuilding. Actions to decrease incidental mortalities should be enhanced under the rationalization program both through the implementation of IFQs (that make harvest overages less likely) as well as the decrease in bycatch mortality. The State has and would continue to review and update their harvest strategies based on the best available scientific information.

The potential conservation benefits of rationalization would improve stock rebuilding. Predicted benefits include a decrease in bycatch of non-legal crab, decreased handling mortality, and improved ability to harvest the TAC without overages. Potential negative impacts of rationalization on stock rebuilding may result from lengthening the seasons, allowing more gear on the grounds, and incentives to highgrade. We can assume these potential negative impacts will not jeopardize stock rebuilding because they will be offset by the positive conservation benefits. If further analysis shows that highgrading, longer seasons, and more pots result in a larger portion of the crab stocks being subject to capture, then the rebuilding harvest strategies will need to be adjusted more conservatively to account for this increase in crab mortality. Additionally, if longer seasons and more pots expand the fisheries over a larger area and increase the portion of the stock encountering gear, then we may want to analyze the benefits of closing specific areas to crab fishing to protect stock rebuilding.

High harvest effort relative to total allowable catch

This relevant issue includes the number of vessels participating, the number of pots fished, and how the crabs are handled. Harvest methods also include the extent to which fishermen comply with regulations. Concern over harvest methods is focused on the impacts on the crab resource that causes additional mortality on legal male crab and on sublegal or female crab. There are three indicators of impacts: the handling of crab, the amount of harvest effort, and the manageability of fisheries.

Safe and timely handling of the crab brought on board indicates how rational the fishery operation is and how much stewardship is embraced by the harvesters and crew. As noted above, the preferred alternative slows the pace of fishermen, allows pots to sort crab in the water and allows fishermen to pick better weather conditions; all of which promotes better handling. The preferred alternative should also increase stewardship with the provision of captain shares. When a quota holder is on board during a fishery operation, the long-term gains of a healthy resource are thought to have a more meaningful impact on the day-to-day operations than short-term returns to individuals not directly participating. Expanding fishing seasons within the biological period would provide fishermen a wider selection of better weather days, potentially reducing handling mortality.

High harvest effort is an indicator of an overcapitalized, over capacity fleet. The problem portrays itself by an excessive number of vessels and gear being deployed in relation to the available harvest limit. Harvest effort above the amount needed to efficiently harvest the GHL can result in crab harvests exceeding the GHL or excessively conservative management measures to protect stocks that lead to under harvest, increased bycatch, and increased habitat impacts. While current pot limits have generally resolved the pot loss problem and some wasteful fishing practices, the full benefit of the current harvest strategies cannot be achieved under derby fisheries where fishermen do not allow pots to soak long enough to sort unwanted crab on the bottom. Alternative 2 would directly address the problem of high harvest effort by reducing capacity through IFQ buyouts and allowing vessels to combine and fish quota from other vessel owners.

ADF&G's ability to properly manage crab fisheries is a further indicator of changes in harvest methods. Under current derby fisheries, over or under harvest can occur. Harvest strategies that promote stock health or stock rebuilding are hampered by competitive fishing activity. The implementation of a rationalization program and the accompanying complimentary Board regulations should greatly improve the manageability of the fishery and allow fishermen to focus on product quality and lower operational costs.

4.2.2.3 Alternative 3

This section, provided by ADF&G, addresses the effects analysis for Alternative 3, the IFQ alternative. These effects are thought to be similar to those for the preferred alternative. Both would be IFQ style fisheries, and would have similar management approaches and strategies, as well as similar concerns.

King and Tanner crab stocks exhibit high amplitude variation in stock abundance over time due largely to wide variation in annual recruitment. The wide variation in annual recruitment that has been observed over the history of the fisheries is generally believed to reflect the effects of the physical and biological environment. Nonetheless, at least some weak effects of the abundance of mature animals on future recruitment have been demonstrated for some stocks; for all stocks it is known that mature animal abundance must have an effect on future recruitment at some critical lower level of abundance. Hence fishery management practices have been developed under the BOF policy on king and Tanner crab resource management goals and benefits with the intent of minimizing irreversible adverse fishery effects on future stock recruitment and allowing for rebuilding of depressed stocks. For example, harvest strategies developed under these policies serve the goal of maintaining adequate mature stock for rebuilding and future recruitment by: maintaining multiple size and year classes of mature animals; lowering harvest rates with decreases in mature stock abundance; setting minimum stock threshold levels for fishery openings; and minimizing handling and mortality to females, undersized males, and other non-target animals. Changes in fishing practices under rationalization could facilitate implementation of such practices in many cases, while in other cases it could make implementation more difficult. In any case, management measures under rationalization would continue to be guided by the BOF's policy for king and Tanner crab and would adjust accordingly to any changes in fishing practices fostered by rationalization. Given that, and as in the case of the preferred alternative, any benefits or losses to the goal of maintaining and rebuilding stocks under rationalization would be small relative to the overriding role of environmental influences on stock levels and recruitment.

This effects analysis addresses the relevant issues raised in the EIS scoping process for BSAI crab rationalization. These relevant issues are concerns brought forward by the public during the scoping process and/or identified in the Council's problem statement. The issues, similar to those for the preferred alternative presented in Table 4.2-14, have associated indicators that describe the potential impact of the IFQ alternative. As with the preferred alternative, the appropriate managing entity would take action or utilize management tools to address the relevant issues within the context of crab rationalization.

The FMP has adopted a management hierarchy that retains certain authority for the Council and NOAA Fisheries (such as limited access management), the BOF, and ADF&G. Coordination between these entities is required to bring a balance that achieves the management goals and maximizes the conservation of the resource. Additionally, management coordination provides the economic and social benefits envisioned in the alternative rationalization programs. It is a combination of both the federal action adopting the IFQ program and actions by the BOF to change its regulations that would provide a coordinated effort to address these issues under this alternative.

Alternative 3 proposes changes for Category 1 management measures to implement an IFQ program. Section 4.1.1 of this document explains that the BOF may adopt or change a number of regulations under Category 2 or 3 management measures to address the relevant issues. The BOF, or the Secretary of Commerce, could adopt or change regulations (management tools) which address the impacts on the relevant issues.

Fishery sources of legal male crab mortality

This issue has three indicators: Harvest above GHL, highgrading and deadloss. Alternative 3 contains an IFQ program to slow the pace of the fishery and improve fishing practices. Under an IFQ program, each fisherman has a certain amount that they are allowed to catch and retain. This prevents harvest above the GHL, with proper catch accounting and penalties for overages, because each fisherman is constrained to harvest their IFQ. It additionally would require a change to the FMP that allows the State to move from GHL to TAC management. As noted in Section 4.1.1, TAC setting may provide a more enforceable tool that assures the season's allowable catch would not be exceeded. The State's actions would include adoption of TAC accounting of both live and dead crab and review regulations on retention of landed crab.

Under status quo, each fishery has a minimum GHL for fishery opening to maintain the ability to manage the fishery inseason. If the calculated GHL is below the minimum GHL, then the fishery is not opened. The minimum GHL prevents a large number of vessels from greatly exceeding a small fishery's GHL before managers can close the fishery. Under alternative 3, a minimum GHL may not be necessary because the harvest amount would not exceed the quota allocation. Additionally, with a small quota, fishermen may transfer quota so that only a small number of vessels harvest the TAC. Removing the minimum GHL would result in allowing fishing to continue at lower stock sizes than under status quo.

Highgrading under an IFQ fishery can have negative consequences to stock health. With the slowing down of the fishery comes the opportunity to target on larger and better quality crab. This results in highgrading activity on older, more robust crab. As with the preferred alternative, State management tools to address this would include reviewing the observer program to consider whether the current coverage level is adequate to assess fishery changes, reviewing current harvest strategies adopted by the Board, and a review of harvest patterns if there is a need to impose gear changes such as setting maximum and minimum escape mechanisms within pots.

Deadloss is an indicator of poor handling and is expected to decrease under the IFQ program. This should occur under this alternative because the fishery pace is slowed for individual IFQ fishermen and there would be coordinated harvests. The slower fishery and the federal IFQ regulations could also enhance enforcement through more thorough landings observations and penalties for not reporting deadloss crab. The State's actions would include adoption of TAC accounting of both live and dead crab and review regulations on reporting of deadloss crab. However, such regulations may be difficult to enforce, and the BOF would have to consider their value.

Bycatch

Bycatch in the crab fisheries is predominantly female and small male crabs of the target species and other crab species. All bycatch is discarded at sea. In general, bycatch should decrease under Alternative 3 due to changes in fishing practices and increased monitoring. To reduce discards of non-target crab, State regulations could be considered to provide for multispecies retention for cooperative members.

Alternative 3 would slow the individual fisherman's harvest pace and better allow the pots to sort crab on the bottom. This in turn results in (a) longer pot soak times to sort out unwanted catch on the bottom; (b) less crowding in areas of high crab productivity; and (c) ability to avoid marginal grounds where unwanted bycatch is often found, and (d) improve handling of crab of deck. The State would consider expanding the harvest season within the biological seasons to improve harvest of target species and reduce bycatch. With the slowing down of the fishery comes the opportunity to let the pots soak longer on the bottom, which results in more selective catches of legal males and greater escape of sublegal males and females. Longer seasons and relaxed pot limits would allow required crab pot escape mechanisms to more effectively sort on bottom. Given this opportunity, it is assumed the fishermen would soak pots longer to maximize the retained catch per pot pull and reduce bycatch. Fishermen want to avoid bycatch because, besides being wasteful, bycatch means sorting on deck, which takes time away from pulling pots. Research has shown that longer soak times result in more sorting by the gear's escape mechanisms. With more soaking time, the more time the smaller female crab have to escape from the pot. The same holds true for sublegal male crab. However, if pots soak too long, then mortality may actually increase due to predation by octopi and amphipods. Fishermen will need to determine optimal soak time long enough to allow females and sublegal males to escape but not so long that the crabs in the pot suffer from predation.

Formation of voluntary cooperatives can further reduce these impacts as members fish cooperatively and help fellow members stay away from areas of high bycatch. Increased season lengths, if adopted by the BOF, would allow fishermen the opportunity and time necessary to search for fishing grounds with lower concentrations of bycatch. This is possible because most stocks tend to segregate geographically by size and sex. Female and small male crab could be better avoided. Additionally, fishermen could exchange instantaneous information about catch rate and mix of harvest. If one member of the cooperative experiences high catches of females and sublegal males, the rest of the vessels in the cooperative would be alerted to avoid the area of high bycatch. Additionally, state managers monitoring a slower paced fishery, would be in a better position to issue timely in-season area closures to move fishermen out of areas of high bycatch.

Handling mortality of bycatch is expected to decrease as handling practice improve with longer fishing seasons and the end of the derby fisheries. Old-shell crab, which may be an important reproductive component in the population, females, and sublegal males could be sorted quickly and returned unharmed. Handling mortality is discussed in more detail below in this section.

Harvest strategies developed for Bering Sea king and Tanner crab stocks since the mid-1990's account for assumed bycatch and handling mortality of non-retained crabs in the determination of the harvest rate on mature or legal-sized males. Under alternative 3, the harvest strategies would continue to account for assumed bycatch and handling mortality in establishing the TAC for legal males. But these may be adjusted if bycatch impacts can be determined to have diminished under the rationalized fishery. A decrease in discards would decrease the total fishery mortality relative to the TAC. As a result, managers may allow for greater directed harvests. Conversely, if discards increase due to highgrading, then the total fishing mortality would increase relative to the TAC and managers would likely reduce directed harvest limits to account for the harvest of a smaller segment of the population. Additionally, the imposition of TACs would reduce bycatch by curtailing fishing once the harvest quota is taken.

Information on the amount of females and sublegal males caught as bycatch is gathered by on-board observers. This information is then used by managers to assess the total fishery removals and to estimate the effects of the fishery on stock abundance. The BOF would also review existing observer coverage levels to determine if these levels should be adjusted in any manner to scientifically determine changing bycatch levels. Increased monitoring would provide more explicit estimates of total fishing mortality, which would improve the information used in the TAC setting process, resulting in more accurate TAC levels.

Rebuilding depressed stocks

Stock rebuilding is an issue of concern when stocks are at depressed levels. The abundance of overfished stocks in the fishery would be the first indication of whether or not the rationalization program is having a positive or negative affect on stock rebuilding. While the current understanding of crab biology suggests that environmental conditions are the single most important components driving recruitment failure, conservative management is needed to assure that the spawning biomass is sufficient to produce rebuilding when environmental conditions are favorable. Actions to decrease incidental mortalities should be enhanced under a one-pie voluntary cooperative alternative both through the implementation of TAC management (that eliminates harvest overages) as well as the decrease in bycatch mortality. The State would continue to review and update their harvest strategies and rebuilding plans.

High harvest effort relative to total allowable catch

This relevant issue includes the number of vessels participating, the number of pots fished, and how the crabs are handled. Harvest methods also include the extent to which fishermen comply with regulations. Concern over harvest methods is focused upon the impacts on the crab resource that causes additional mortality on legal male crab and on sublegal or female crab. Three indicators of these impacts are: the handling of crab, the amount of harvest effort, and the manageability of fisheries.

Safe and timely handling of the crab brought on board indicates how rational the fishery operation is and how much stewardship is embraced by the harvesters and crew. As noted above, Alternative 3 slows the pace of fishermen, allows pots to sort crab in the water and allows fishermen to pick better weather conditions; all of which promotes better handling. Because this alternative also includes consideration of attributes like captain's shares, this should also increase stewardship as well. When a quota holder is on board during a fishery operation, the long-term gains of a healthy resource are thought to have a more meaningful impact on the day-to-day operations than short-term returns to individuals not directly participating. Additionally, the State would propose that the BOF consider expanding fishing seasons within the biological period so that fishermen would have a wider selection of better weather days.

High harvest effort is an indicator of an overcapitalized, over capacity fleet. The problem portrays itself by an excessive number of vessels and gear being deployed in relation to the available harvest limit. Harvest effort above the amount needed to efficiently harvest the limit can result in crab harvests exceeding the limits or excessively conservative management to protect stocks that lead to under harvest, increased bycatch, and increased habitat impacts. While current pot limits have generally resolved the pot loss problem and some wasteful fishing practices, the full benefit of the current harvest strategies cannot be achieved under derby fisheries where fishermen do not allow pots to soak long enough to sort unwanted crab on the bottom. This alternative would directly address the problem of high harvest effort by reducing capacity through IFQ buyouts and allowing vessels to fish quota from other vessel owners through leasing.

ADF&G's ability to properly manage crab fisheries is a further indicator of changes in harvest methods. Under current derby fisheries, over or under harvest can occur. Harvest strategies that promote stock health or stock rebuilding are hampered by competitive fishing activity. The implementation of an IFQ program and the accompanying complimentary BOF regulations should greatly improve the manageability of the fishery and allow fishermen to focus on product quality and lower operational costs.

4.2.2.4 Alternative 4

The effects of alternative 4, a cooperative with a closed class of processors, are thought to be identical or very similar to those for the preferred alternative, as well as the IFQ alternative. Again, all would be IFQ style fisheries, and would have similar management approaches and strategies, as well as similar environmental concerns. Working with a closed class of processors, as is the case in the AFA Bering Sea pollock fishery, should not change fishery management strategies proposed under the other two IFQ alternatives. Effects from this style of fishery on crab stocks would be similar to the other proposed alternatives.

4.3 Predicted effects on other biological resources

Section 4.3 describes the biological resources, other than commercial crab species, in the BSAI that could be effected by the alternatives. This section analyzes the effects of the alternative programs as a whole on the other biological resources. The relevant issues identified for the effects of the alternatives on these resources are: bycatch, habitat impacts, and impacts on Endangered Species Act (ESA) listed species and their critical habitat. Each of these issues are discussed below. Indicators for each issue have been identified. These indicators are potential impacts of the alternatives, including status quo. Indicators are used as analytical tools for measuring significance and comparing the effects of each alternative on the issue. From the analysis, the extent to which each alternative results in an increase or decrease in each indicator will be discussed. Indicators can be mitigated by management measures incorporated into the preferred alternative.

Bycatch (not FMP crab)

The crab fisheries catch a small amount of other species as bycatch. These species include octopus, Pacific cod, Pacific halibut, and other flatfish, sponges, coral, and sea stars. All bycatch is discarded at-sea.

Indicator: Bycatch of other species in BSAI crab fisheries

Potential effects of the different alternatives will be estimated based on the amount of bycatch of other species. Observer data is used to estimate bycatch of other species.

Habitat impacts

The crab fisheries may impact benthic bottom habitat through the setting and retrieval of pots. The extent of habitat impacts depends on the gear used, the type of bottom habitat fished, and the portion of that habitat type utilized by the fishery.

Indicator: Area and habitat type impacted

Potential effects of the different alternatives will be estimated based on the total area impacted by pot gear and the extent to which pot gear impacts different habitat types.

Impacts on physical environment in vicinity of processors

Crab processing impacts the physical environment in the vicinity of processors.

Indicator: Waste discharge

Potential effects of the different alternatives will be estimated based on the accumulation of benthic waste, concentration of biochemical oxygen demand, and discharge of suspended solids.

Fishery impacts on Endangered Species Act species and their critical habitat

Fisheries can effect listed species of marine mammals and seabirds and their critical habitat. This analysis will look at the effects of the crab fisheries and their alternatives on ESA species and their critical habitat

Indicators: Direct take, disturbance, and competition

Potential effects of the different alternatives will be estimated based on the extent of direct take of listed marine mammals and seabirds, disturbance of listed marine mammals and seabirds by fishing vessels, and competition between the fisheries and listed marine mammals and seabirds for food.

4.3.1 Benthic species and habitat

This section analyses the effects of the alternatives on benthic species and habitat in the areas where the crab fisheries are prosecuted. Potential effects of the different alternatives are estimated based on the extent of bycatch of other species in the crab fisheries and on the extent that pot gear impacts habitat and benthic species. The relationship of crab species and the crab fisheries to the species and habitat on seafloor of the BSAI is described in section 3.3.1. Additionally, section 4.4 provides the essential fish habitat assessment.

Table 4.3-1 Significance Table for benthic species and habitat. Criteria for determining the significance of direct and indirect effects of the BSAI king/Tanner crab fisheries on benthic species and habitat: significant adverse (S-), insignificant (I), or unknown (U).

Effects	**Score**		
	S-	I	U
1. Mortality of benthic species from bycatch and pot gear (observed and unobserved)	Level of mortality likely to decrease population abundance.	Level of take not likely to have population level effect on species.	Insufficient information available on bycatch rates or population levels.
2. Species diversity in the benthic community	Level of take in fisheries cause declines in species diversity in the benthic community.	Level of take not likely to cause changes in species diversity.	Insufficient information on fishery impacts to species diversity in the benthic community.
3. Habitat	Fishery induced disruption or damage of habitat that is more than minimal and not temporary.	Level of disruption or damage that is minimal and temporary.	Insufficient information on the scope of habitat impacts.

Table 4.3.-2 Summary table of effects of each alternative on benthic species and habitat.

Effect	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Mortality of benthic species from bycatch and pot gear (observed and unobserved)	I	I	I	I
Species diversity in the benthic community	I	I	I	I
Habitat	I	I	I	I

4.3.1.1 Benthic species caught as bycatch in the crab pot fisheries

In this section, potential effects of the different alternatives is estimated based on the extent of bycatch of other species (not FMP crab) in the crab fisheries. A description of available information on the species caught as bycatch is in Section 3.3.1. The ADF&G observer program collects information on the different species caught as bycatch and the amount of each species observed. The ADF&G observer program publishes an annual summary of the observer program database. The most recent bycatch data for other benthic species in crab pots in the Bering Sea was available from the ADF&G observer program report (Barnard et al. 2001) describing three 1999-2000 BSAI crab fisheries; Bering Sea snow crab, Bristol Bay red king crab, and Aleutian Islands golden king crab (all other crab fisheries were closed). Table 4.3-3 summarizes the major species caught, estimated number taken in each fishery, and total number taken during the season.

Table 4.3-3 Bycatch estimates for Bering Sea and Aleutian Islands crab fisheries, 1999-2000.

Bycatch Species	Bering Sea Snow crab	Bristol Bay Red King Crab	E. Aleutian Islands Golden King Crab	W. Aleutian Islands Golden King Crab	TOTAL (number)
Fish					
Pacific Cod	272,102	98,964	2,147	3,031	376,244
Walleye Pollock	10,204	693	72	0	10,968
Flatfish miscellaneous	0	792	788	303	1,883
Halibut	3,401	2,969	8,944	3,031	18,345
Yellowfin Sole	0	74,223	0	0	74,223
Arrowtooth Flounder	0	1,484	0	303	1,788
Skate unid	0	0	1,431	202	1,633
Sculpin unid	10,204	19,793	501	404	30,902
Bigmouth Sculpin	850	0	72	101	1,023
Great Sculpin	0	16,824	72	101	16,996

Table 4.3-3(Cont.) **Bycatch estimates for Bering Sea and Aleutian Islands crab fisheries, 1999-2000.**

Bycatch Species	Bering Sea Snow crab	Bristol Bay Red King Crab	E. Aleutian Islands Golden King Crab	W. Aleutian Islands Golden King Crab	TOTAL (number)
Gastropods					
Snail unid	340,128	3,959	4,293	2,021	350,400
Neptunea borealis	3,401	99	0	0	3,500
Echinoderms					
Sea Star	37,414	54,430	2,147	2,021	96,012
Brittle Star	0	0	24,327	3,031	27,359
Basket Sea Star	0	0	4,293	3,031	7,324
Sea Urchin	0	0	2,147	2,021	4,167
Other Crabs					
Scarlet King Crab	0	0	716	8,083	8,799
Hermit Crab unid	5,102	990	72	101	6,264
Lyre crab	3,401	396	572	404	4,774
Korean Hair crab	0	990	72	202	1,264
Other Invertebrates					
Sponge	0	0	16,457	6,062	22,519
Octopus	3,401	99	72	303	3,875
Sea Anemone	850	0	72	0	922
Jellyfish unid	850	0	0	0	850

Notes: unid - unidentified
Source: Barnard et al. 2001

Effects of Alternative 1

The crab fisheries catch a small amount of other species as bycatch. Bycatch in the crab fisheries includes octopus, Pacific cod, Pacific halibut, and other flatfish. Data collected by the ADF&G observer program indicate that bycatch of non-crab species is low. All bycatch is discarded at-sea. There is no way of estimating what percentage of discarded organisms die, but even if mortality was 100 percent, it is not probable that this bycatch impacts the abundance of these species. Based on the analysis below, the effects of Alternative 1 on species caught as bycatch in the BSAI crab fisheries are insignificant.

Fish: Fish including a number of crab predators, especially Pacific cod, halibut, yellowfin sole and sculpin account for the greatest proportion of estimated crab pot bycatch. These species are widely distributed and highly abundant representatives of the greater groundfish community. The Alaska Groundfish Fisheries Final Programmatic Supplemental EIS contains a complete description of the life history, habitat, and stock status for these species (NMFS 2004a).

Pacific cod are thought to be the greatest predator of young snow and Tanner crabs in the eastern Bering Sea (Jewett 1982; Livingston 1989). Cod were caught as bycatch in greatest abundance in both Bering Sea snow crab and Bristol Bay king crab fisheries. The 376,000 cod estimated as bycatch in 2000 crab pot fisheries are relatively insignificant in comparison to the average 220,000 metric tons (mt) taken annually by all dedicated fisheries for Pacific cod in the BSAI (hook and line, trawl and pot fisheries data from 1994-1998) (NMFS 2003b).

Yellowfin sole were caught exclusively by the Bristol Bay red king crab fishery. Yellowfin sole are second most common predators of larval and juvenile snow and Tanner crab after Pacific cod (Livingston et al. 1993). These sole have a relatively stable biomass of about 2 million tons per year in the Bering Sea (NMFS 2003b) and thus a potential loss of 74,000 yellowfin sole due to crab pot bycatch would be minimal.

Sculpin are recognized as being among the major predators of snow and Tanner crab and are thus attracted to crab pots (Feder and Jewett 1981). Sculpin including Bigmouth *(Hemitripterus bolini*) and Great Sculpin (*Myoxocephalus polyacanthocephalus*) experienced the third highest bycatch mortality (~49,000 fish; 3 categories of sculpin combined from Table 4.3-1) during the 2000 crab pot fisheries. Snow crab have been shown to comprise 50 percent by weight of the diet of great sculpin in the eastern Bering Sea while Bigmouth sculpin diets are thought to be mostly (>90 percent) comprised of fish, especially cod (Brodeur and Livingston 1988 as cited in NMFS 2003b). Biomass of sculpin (*Myoxocephalus spp.)* has remained seemingly constant from 1979-1998 (NMFS 2003b) and thus losses due to crab pot bycatch would be insignificant.

Pacific halibut are also recognized predator of juvenile snow and Tanner crabs. Crabs comprise an estimated 7 percent by weight of Pacific halibut total diet in the eastern BSAI (NMFS 2003b). Halibut bycatch limits of 900 mt are imposed annually on BSAI non-trawl fisheries. Loss of 18,000 halibut to crab pot bycatch would be included in these limits and seem minimal compared to bycatch from trawl fisheries which have a halibut bycatch limit cap of 3,600 mt. Halibut fisheries are closely monitored, heavily regulated and the resource is currently considered to be healthy (NMFS 2003b). Crab pot bycatch losses of halibut are being monitored, highly scrutinized and would be regulated should they exceed established limits.

Walleye pollock support annual groundfish fisheries of 1.2 million mt in the BSAI (1994-1998) (NMFS 2003b). They are not considered to be a major predator of snow and Tanner crab but are attracted to crab pots by the bait. Compared to the great abundance of pollock over the greater BSAI, crab pot bycatch losses of 11,000 pollock would not be significant.

Arrowtooth flounder and skates are also taken as bycatch (about 2,000 fish each category). Arrowtooth are not considered to be crab predators but are attracted to fish in baited pots. Their biomass has been increasing over the past decade in the BSAI (NMFS 2003b) in spite of minor losses due to crab pots. Juvenile skates consume juvenile crab (10 to 40 percent of skate diet by weight) (Livingston and deReynier 1996). Mortality of skates due to crab pot bycatch is insignificant compared to the estimated skate biomass of 377,000 mt in the eastern Bering Sea (Livingston and deReynier 1996).

Gastropods: Snails (including *Neptunea borealis*) were the second most common bycatch category after cod. An estimated 354,000 snails were taken as bycatch in BSAI crab fisheries in 2000. Various species of *Neptunea* were common occupants of recovered Bering Sea crab pots (B. Stevens, NOAA Fisheries Kodiak Lab, personal observation). This genus of snails is the most dominant in the middle and outer shelf areas of the southeast Bering Sea (Jewett and Feder 1981; as cited in NMFS 2001d, Section 3.6.1.1). There was historically a small, Japanese fishery for snails in the Bering Sea since 1971. A United States snail fishery began in 1992 and lasted less than a decade with a peak harvest in 1996 of 3.5 million pounds (lbs.) (worth over $1 million U.S. dollars). Last commercial fishery for snails, with landings of 932,000 lbs., occurred in 1997 (ADF&G 2001).

Echinoderms: Within the BSAI almost 100,000 sea stars, 27,000 brittle stars, 7,000 basket stars and 4,000 sea urchins were estimated to be taken as bycatch during the 2000 BSAI crab fishing seasons. Sea stars were caught in all three crab fisheries but not identified to species. Those taken are most likely of the genera *Asterias*, *Pycnopodia* and/or *Gorgonocephalus*. In the southeast Bering Sea, king and snow crabs rank as the greatest component of total invertebrate epifaunal (animals that live on top of the sea floor) biomass. The sea star (*Asterias amurensis*) represents 12 percent of the biomass at bottom depths 40-100 m, replaced by basket stars (*Gorgonocephalus caryi*) representing 7 percent of total biomass at depths >100 m (Jewett and Feder 1981; as cited in NMFS 2003b). In northeastern Bering Sea, sea urchins and basket stars comprise 22 percent and 56 percent, respectively, of the invertebrate species at bottom depths >40 m (Jewett and Feder 1981; as cited in NMFS 2003b). Since these species represent such a large proportion of the benthic community, loss due to bycatch mortality in the crab fisheries would not be expected to effect their populations.

Non-FMP Crab: Other crab species caught as bycatch include, lyre crabs, hermit crabs and Korean hair crab (*Erimacrus isenbeckii*). Korean hair crab supported a very small dedicated commercial fishery north of the Pribilof Islands. The Korean hair crab bycatch in the Bering Sea amounted to the estimated catch from the 2000 Bering Sea hair crab fishery. This fishery was closed as of 2001 until there is evidence of hair crab recruitment. Information on distributions and abundances of lyre and hermit crab are lacking. Effects of crab pot bycatch are unknown at this time.

Other Invertebrates: Octopus (*Octopus dofleini*) were caught primarily in the Bering Sea snow crab fishery. Octopus are a crab predator and compete with crabs for prey. Since 1995, there has been a small fishery for octopus in the Bering Sea comprised of bycatch from various groundfish fisheries (ADF&G 2001). During 2000, there is still wastage of this resource; 40,000 lbs. of octopus were discarded at sea compared to the 16,000 lbs. that were retained for fish meal and bait. The effect of octopus mortality due to crab pot bycatch is unknown.

Jellyfish and sea anemones would not be expected to sustain significant impacts from crab pot fishing. Biomass of jellyfish has increased tenfold in the Bering Sea in the past decade with greatest increase occurring over the mid-shelf domain, at 50-100 m depths (NMFS 2003b).

Sponge and corals are routinely hauled up with crab pots that fish deeper waters along the Aleutian Islands for golden king crab. An estimated 22,500 sponges were destroyed by crab pot fishing in 2000. It is assumed that these sessile organisms are not able to reattach to the substrate when returned to the water and thus will die. Destruction of sponge and corals may be crucial to some species of small benthic organisms including newly settled crabs as they provide valuable habitat structure and protection from predation. The ADF&G shellfish observer program has begun to collect coral bycatch data and species composition in the Aleutian Islands golden king crab fisheries to learn about amount caught as bycatch and the variety of coral species. ADF&G, in collaboration with NOAA Fisheries, is developing *A Field Guide to Alaskan Corals* (Wing and Barnard, in prep.) to enable data collection of corals caught in the golden king crab fishery. The extent of coral bycatch is presumed to be insignificant because the golden king crab fisheries occur in a small percentage of coral habitat.

Crab pot bycatch is deemed insignificant for any population of other benthic species routinely caught in the major eastern Bering Sea crab fisheries. Fishes including Pacific cod, yellowfin sole, Pacific halibut, sculpin, walleye pollock, other flatfish, and skates all have very high abundance relative to the level of estimated pot bycatch. Gastropods and echinoderms comprise a major portion of the total biomass of the eastern Bering Sea and small losses due to pot bycatch would have little significance. In some cases crab pot bycatch have become part of small dedicated fisheries as for snails, octopus, and Korean hair crab. Minor losses of other invertebrates are not estimable but assumed to be relatively insignificant. In addition, the minor amount of these species caught as bycatch does not result in declines in species diversity because it does not cause a decline in any species abundance. From this information, NOAA Fisheries concludes that status quo has an insignificant effect on the population levels of benthic species caught as bycatch.

Effects of Alternatives 2, 3, and 4

The rationalization program alternatives may reduce the effects of the crab fisheries on these benthic species because the alternatives would change the prosecution of the crab fisheries. The predicted effects of each rationalization program alternative on the prosecution of the crab fisheries is in Section 4.1. The predicted changes that may effect benthic species include a reduction in the amount of gear deployed, longer soak times for pots, and a lengthening of the fishing season. Longer soak times may decrease the amount of these species caught as bycatch because it may allow some organisms to escape from the pot, assuming these species can escape through the escape mechanisms required on all pots. A decrease in the number of pots deployed and in the number of pot lifts would decrease species' the exposure to capture. Because the rationalization program alternatives would not increase the effects of the fisheries on benthic species, it is concluded that they will have an insignificant effect on benthic species because the level of bycatch would not impact the abundance of these species.

4.3.1.2 Habitat and benthic species impacted by pot gear

This section will first discuss the ways which pot gear impacts benthic habitat and then analyze the effects of the alternatives on benthic habitat.

The following types of habitat are impacted by the BSAI crab fisheries. Red king crabs are mostly taken in areas consisting of sandy and silty bottoms at depths of 20 to 80 fathoms (120 to 480 feet). This bottom is typically flat, without marked features or steep slopes. Occasionally red king crab may be taken on shell hash, gravel, or cobble bottoms. They frequently feed on sand dollars, starfish, clams, scallops, and various marine worms in these areas. Norton Sound red king crabs are taken primarily in areas consisting of sandy and silty bottoms at depths of 25 fathoms (150 feet) or less. Blue king crabs are taken at depths of 15 to 60 fathoms (90 to 360 feet) on hard bottom, including cobble, gravel and occasional rock ledges near shore, and softer bottom off shore. Tanner crabs are taken in areas of soft sediment types (silt, mud) at depths of 30 to 110 fathoms (180 to 660 feet). Tanner crabs tend to inhabit the warmer waters of the Bering Sea where summer bottom temperatures exceed 4°C. These occur in western Bristol Bay, the Pribilof Islands, and along the shelf edge. Snow crabs are taken in areas of soft sediment types (silt, mud) at depths of 40 to 110 fathoms (240 to 660 feet). They are generally found in colder areas of the Bering Sea where summer bottom temperatures are less than 4°C. These areas occur in the mid-shelf region of the central portion of the eastern

Bering Sea shelf. In areas of overlap with Tanner crab stocks, hybridization occurs. The benthic species potentially impacted by pot gear are described in Section 3.3.

Pot gear impacts

Physical damage from pots is highly dependent on habitat type. Sand and soft sediments are less likely to be affected, whereas reef-building corals, sponges, and gorgonians (a type of branching coral) are more likely to be damaged because of their three-dimensional structure above the seafloor (Quandt 1999). Pots are considered to be less damaging than mobile gear, because they are stationary in nature, and thus, come into direct contact with a much smaller area of the seafloor. Pots affect habitat when they settle to the bottom and when they are hauled back to the surface (Eno et al. 2001, Stewart 1999). Lost pots also impact benthic species by continuing to capture and kill them, which is known as ghost fishing.

Eno et al. (2001) observed effects of pots set in water depths from approximately 14 to 23 m over a wide range of sediment types in Great Britain, including mud communities with sea pens, limestone slabs covered by sediment, large boulders interspersed with coarse sediment, and rock. Observations demonstrated that sea pens were able to recover fully from pot impact (left in place for 24 to 48 hours) within 72 to 144 hours of the pots being removed. Pots remained stationary on the seafloor, except in cases where insufficient line and large swells caused pots to bounce off the bottom. When pots were hauled back along the bottom, a track was left in the sediments, but abundances of organisms within that track was not affected. Authors did record incidences of detachment of ascidians (sea squirts or tunicate) and sponges and damage to rose coral, but it was not clear if these resulted from this study or from previous damage. Authors conclude that no short-term effects result from the use of pots, even for sensitive species. The study did not examine chronic effects. It is important to note that the pots used off Alaska are much larger and heavier than those in any of the studies cited.

The area of seafloor contacted by each pot during retrieval is unknown and expected to strongly depend on vessel operations, weather, and current. Recovery of pots often involves dragging them across the seafloor, especially during storms, or if they are heavily sanded in. Lost pots continue to capture benthic species until their degradable mesh degrades. No studies have been conducted on the effects of these activities. It is difficult to assess the extent of these impacts when little evidence is brought on deck and we cannot see what occurs on the ocean floor.

Mortality of benthic animals during pot deployment and recoveries

On the broad sandy shelf of the eastern Bering Sea, the most likely impact is damage or mortality to other crabs in the vicinity or those hanging onto the outside of the pot. Damage may also be done to other sea life including fish, snails, sea stars, and bivalves. An organism of particular concern is the sea onion (*Boltenia ovifera*) which provides an important habitat for young of the year red king crabs (Stevens and Kittaka 1998). Sea onions are damaged and removed by on-bottom trawls (B. Stevens, NOAA Fisheries AFSC Kodiak Lab, personal observation), and probably by dragging crab pots as well. Although commercial trawling is prohibited in the area of sea onions' greatest abundance, pot fishing is most heavily concentrated there. Removals of sea onions may limit the carrying capacity of the environment for recruitment of juvenile king crabs. Fishing with pots may also create impacts by crushing, burying, or disturbing female crabs in areas of mating aggregations, according to Stevens et al. (1994), and testimony by B. Stevens to the Alaska Board of Fisheries (March 2002).

While fish are able to escape when pots are being retrieved, and snails and bivalves (mussels, clams) have their protective shells, echinoderms (sea stars, urchins) may be more vulnerable to damage during pot recovery. Starfish may be crushed or buried during pot deployment. Compared to sea stars and sun stars, brittle stars and basket stars are probably more vulnerable to limb damage due to handling during crab pot retrieval. Mortality experienced by echinoderms due to crab pot fishing has not been estimated. Starfish compete with crabs for prey and brittle stars form a major prey item for snow and Tanner crab. Since starfish are generally very abundant and widely distributed across the eastern Bering Sea, losses due to crab pot fishing are likely not significant.

The Aleutian Islands golden king crab fishery is the only crab fishery identified as potentially adversely effecting benthic habitat. Golden king crabs are taken in areas consisting of rough, uneven bottom at depths of 100-400 fathoms (600 to 2,400 feet). Fishery effort is concentrated on rocky substrata and pinnacles in the Aleutian Islands and at the entrances to passes between the islands. Such habitats are home to many sessile (attached) animals including gorgonian corals, anemones, sea stars, crinoids (a type of echinoderm), and sponges. These organisms supply shelter and food to small crabs, fish, and other organisms. Pot fishing in these areas probably has significant impacts on the hard-bottom fauna, but has not been studied. Corals and sponges are long-lived animals; once damaged or broken, they may never recover. Witherell and Coon (2000) provide a comprehensive overview of the corals off Alaska, including coral distribution and fishing effects. Coral can be damaged by the setting and retrieval of pot gear, especially longline pot gear. Little information exists on the effects of longline pot gear on coral or on the benthic habitat of the Aleutian Islands. Longline pot gear causes damage because the pots are tied together on the same groundline. These pots come on deck with rocks, coral, and other things from the sea floor. The golden king crab vessels have 100 percent observers, so data on the types and frequency of coral bycatch is being recorded. The ADF&G observer program has begun to collect and build a database on the locations and species of coral brought on deck in the Aleutian Islands golden king crab fishery. Continued observer data collection focusing on recording where and which types of coral are brought up in the fishery would improve our understanding of this issue.

Habitat degradation from pot gear cannot be estimated at present. Additional mortality to fish, echinoderms, gastropods, other non-target crabs, and invertebrates like octopus and sponges is indeterminable. Some species including sponges and corals, sea and brittle stars may be more vulnerable than other species.

Ghost fishing by lost pots

Increased mortality of fish and non-target invertebrates from ghost pot fishing in the Bering Sea has not been fully studied. Lost by the fishery, these pots may continue to entrap crab and fish until their netting or escape panels disintegrate (Stevens et al. 2000). As ghost pots are unbaited, the primary attraction of derelict pots is their physical structure, which adds complexity and vertical relief to the generally featureless environment in the Bering Sea. Estimates of number of pots lost per year and length of time a pot continues to fish has led Stevens et al. (2000) to predict impressive potential losses for Kodiak crabs although impact on other species is not known. Benthic organisms found in lost pots in Kodiak included Sunflower stars (*Pycnopodia helianthoides*; 42 percent occurrence), hairy tritons (*Fusitriton oregonensis*; 15 percent occurrence), and white anemones (*Metridium senile*; 3 percent occurrence) (Stevens et al. 2000). Octopus (*Octopus dofleini*) occurred in all pots with >10 crabs and are a significant source of crab mortality. In the Bering sea, various species of Neptunea, the sea star (*Asterias amurensis*) are common occupants of recovered crab pots, but numbers are not known (B. Stevens, NOAA Fisheries, AFSC Kodiak Lab, personal observation).

Derelict pots add vertical structure that is frequently colonized by sedentary invertebrates altering the local environment. Fish, crabs and other organisms are attracted to derelict fishing pots (ghost pots) even after all bait has decomposed; pots continue to fish in a self-baiting cycle. Crabs and fish continue to be trapped and die due to starvation or cannibalism. Alaska pot fisheries are required to install untreated cotton twine in pot walls that degrade to eventually stop ghost fishing.

Estimates of pot loss rates are unreliable, but may have been as high as 20,000 pots per year in the late 1980s (Alaska Board of Fisheries as cited in Paul et al. 1994); even 10 percent loss per year would contribute 5,000-10,000 lost pots each year. Using sidescan sonar, Stevens et al. (2000) estimated the number of ghost pots in a 4.5 km^2 area of Chiniak Bay, Kodiak Island, to be 42 pots km^2. Extrapolation to a 40,000 km^2 area of the Bering Sea (where fishing for king, Tanner, and snow crab is particularly intensive) would predict an estimate of 1.68 million pots in various stages of degradation. Assuming a half-life of 4 years, and 7,000 pots lost annually, Stevens (1996) estimated the number of active ghost pots would stabilize at 44,000 after 40 years. The actual number is probably somewhere between these extremes.

Catch per unit of effort of lost pots is a function of both background crab density and pot condition. In Chiniak Bay, Kodiak Island, lost pots (< 1 year old) had significantly more male crabs, significantly larger male crabs, and contained seven times more total crabs (4 crabs per pot) than older pots (<1 crab per pot) (Stevens et. al. 2000). Extrapolating this estimate to the Bering Sea, assuming 100,000 lost pots, and crab recapture rates of 1 crab/week, with 50 percent mortality, potential mortality of crabs could be 2.6 million mature crabs per year (estimate does not account for pots with degradable mesh).

Management measures to reduce ghost fishing limit the number of pots a fisherman can use and require that each pot be equipped with a degradable panel. Since 1996, ADF&G has required pots to have a panel of degradable mesh to reduce ghost fishing. Degradable panels decrease the amount of time a lost pot can ghost fish because once a panel degrades, the pot can no longer capture crab or other benthic species. Lost pots cause other problems besides ghost fishing. Since pots are hard structures, they can damage the gear used by other fisheries, such as bottom trawl gear.

Effects of Alternative 1

The effects of the status quo BSAI crab fisheries on benthic habitat is analyzed in the EFH EIS (NMFS 2004d) and in the discussion paper, *An Evaluation of Fishery Effects on Essential Fish Habitat off Alaska* (Witherell 2002). This analysis is summarized here. Benthic habitat is used synonymously with EFH in the discussion paper and EIS analysis because virtually all of the seafloor off Alaska has been designated as EFH for one species or another. Section 4.4 contains an analysis of the impacts of the crab fisheries on EFH designated for the managed species in the BSAI.

The EFH EIS determined an overall fishery impact for each fishery based on the relative impacts of the gear used (which is related to physical and ecological effects), the type of habitat fished (which is related to recovery time), and the proportion of that bottom type utilized by the fishery. Fishery effects on benthic habitat are insignificant if the fishery impacts are minimal and temporary in nature. Minimal impacts are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. Temporary impacts are limited in duration and allow the particular environment to recover without measurable impact. This type of habitat is used as a surrogate for determining temporary effects because recovery appears to be strongly correlated with habitat type. The amount of fishing effort on each habitat type is an indicator of minimal effects. The gear used is a component of both minimal and temporary.

Results of this analysis indicate that the BSAI crab fisheries impacts to benthic habitat had no measurable effects (NMFS 2004d). The effects of the BSAI crab fisheries were determined to be minimal and temporary because, combined, the crab fisheries have an extremely small footprint because they impact less than one percent of available habitat. Additionally, the BSAI crab fisheries, except Aleutian Islands golden king crab and Aleutian Islands red king crab, impact habitat types (sand, silt, and mud) that have low recovery times. The Aleutian Islands golden king crab and Aleutian Islands red king crab fisheries occur on slope areas characterized by having rough bottom and living substrates that have a relatively long recovery time. However, because these fisheries impact such a small portion of the available habitat in the Aleutian Islands, it was concluded that these fisheries also have no measurable effects on benthic habitat. Thus, the effects of the fishery are concentrated in an extremely small proportion of total available benthic habitat and these effects are considered minimal and temporary. From this analysis, it is concluded that the BSAI crab fisheries have an insignificant effect on benthic habitat.

Effects of Alternatives 2, 3, and 4

Habitat impacts may change under Alternatives 2, 3 and 4 because, with the allocation of harvester quota share, the fisheries will be spread out in time, thus subjecting habitat to impacts over a longer amount of time. On the other hand, total effort may decrease as the fishery consolidates and as fishermen reduce effort to the level necessary to catch their quota. Although, fewer vessels would fish, each vessel may have more pots if pot limits are relaxed. Most likely, the number of pot lifts will be directly related to the size of the quota. For example, if each pot brings up ten legal male crab, and a fisherman's quota is 100 crab, this effort will be ten pot lifts. And, there is a negligible difference between whether he sets ten pots and lifts each one once or sets one pot and lifts it ten times. With the current level of information, it is impossible to predict the extent to which spreading out the fishery will effect the habitat. At this stage, it is concluded that if the fishery itself does not have a significant effect on benthic habitat, then changes to the fishery as a result of rationalization will also not have a significant effect. Even if fishing effort (expressed in pot lifts) doubles, less that one percent of the Bering Sea will be impacted by pot gear.

Since this fishery is not yet a derby-style fishery, most likely, under the rationalization program alternatives, it would not greatly change in the way it is prosecuted.

It is anticipated that programs of individual quotas and voluntary cooperatives will lead to reduced vessel effort and a more orderly fishery over an extended harvest period. Compared to the current fast pace, competitive derby fishery, the preferred alternative should provide these significant benefits to habitat:

- reduced effort and crowding on marginal grounds;

- temporal redistribution of effort to maximize harvest of target species and minimize bycatch;

- reduced gear loss from fishing marginal grounds or from fishing in concentrated areas, impacting habitat by less ghost fishing of lost gear; and

- increased selectivity of gear for target and non-target species alike and multispecies retention which in turn reduces bycatch mortality of handled and returned crab.

Additionally, the State intends to conduct an evaluation of research on possible closed areas to protect crab spawning, settling, rearing and mating habitat, and to review the crab observer program to ascertain its value in assessing habitat impacts.

Slowing the pace of fisheries under rationalization program alternatives could also potentially reduce gear loss and prevent the conservation concerns associated with ghost fishing. For the crab fisheries, ghost fishing is probably more of a problem in a derby fishery than in a rationalized fishery. Pots are expensive, and most likely, a fisherman would avoid losing pots. In the race for fish, the risk of losing a pot was balanced against the advantage of harvesting more crab. With an allocation of quota, there is less of an incentive to risk losing pots because the harvest amount is guaranteed. However, to prevent fishermen from deploying an unlimited amount of pots, some pot limits may be required to prevent pot loss from ice movement or gear conflicts. If too many pots are deployed at the ice edge, when the ice moves forward, some pots are lost because the vessel that deployed them cannot pick up all the pots before they are covered with ice. The rationalization program alternatives would not change the gear used.

The effect of the rationalization program would be to decrease the fisheries impacts on benthic habitat, compared to status quo. The total area impacts by the crab fisheries under any of the rationalization program alternatives would be less that one percent of available habitat, as with status quo. Therefore, it is concluded that the rationalization program alternatives would have an insignificant effect on benthic habitat.

4.3.2 Marine mammals

This analysis will look at the effects of the crab fisheries under each alternative on ESA listed marine mammals and bearded seals. Potential effects of the three alternatives will be estimated in light of the extent of direct take, disturbance by fishing vessels, and competition between the fisheries and marine mammals for food. The two things to determine are (1) do these effects occur or could they occur under each alternative, and (2) if they do occur, do they occur to an extent that would limit the recovery of a listed species or adversely modify critical habitat. If these effects do occur to an extent that would limit the recovery of a listed species or adversely modify critical habitat, then we conclude that the action would have significant effects on the listed species under the NEPA. If these effects do not occur or are insignificant[1] under the ESA, then it is concluded that the action would have insignificant effects for the purpose of this NEPA analysis.

Table 4.3-4 Significance table for marine mammals. Criteria for determining the significance of direct and indirect effects of the BSAI king/Tanner crab fisheries on marine mammals: significant adverse (S-), insignificant (I), or unknown (U).

Effects	Score		
	S-	I	U
1. Incidental take/entanglement in marine debris	Level of take which would delay recovery or result in a population decline.	Level of take which would have a negligible impact on population.	Insufficient information available on take rates or population trends.
2. Harvest of prey species	Competition for key prey species likely to constrain foraging success of marine mammal species.	Competition for key prey species unlikely to constrain foraging success of marine mammal species.	Insufficient information available on key prey species abundance.
3. Critical Habitat	Adverse modification of critical habitat such that survival or reproductive success is likely to decrease.	Impact to critical habitat such that survival or reproductive success is likely not affected.	Insufficient information on the scope or mechanism of critical habitat impacts.
4. Disturbance	Disturbance of mammal or prey field such that survival or reproductive success is likely to decrease.	Disturbance of mammal or prey field such that survival or reproductive success is likely not affected.	Insufficient information on the scope or effects of disturbance.

[1] The Interagency Consultation Handbook defines insignificant effects as those that a person would not be able to meaningfully measures, detect, or evaluate. If an effect is insignificant according to this definition, it is appropriate to conclude that the proposed action is not likely to adversely affect a listed species or designated critical habitat [see Handbook, page xv].

Table 4.3.-5 Summary table of effects of each alternative on marine mammals.

Effect	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Incidental take/entanglement in marine debris	I	I	I	I
Harvest of prey species	I	I	I	I
Critical Habitat	I	I	I	I
Disturbance	I	I	I	I

Fisheries interact with marine mammals either operationally or biologically (Lowry et al. 1982). Operational effects are direct and occur in the form of incidental takes, which may result in disturbance, serious injury or mortality. Operational interactions between marine mammals and fisheries result from entanglement in actively fishing or derelict fishing gear. Marine mammals become entangled when they encounter derelict or active fishing gear. Operational interactions may directly affect marine mammals populations, but are not likely to directly affect their habitat. Data collected by fishery observer programs allow for the quantification of direct fishery/marine mammal interactions. Biological interactions result from disturbance of normal marine mammal foraging behavior, competition with marine mammals for prey, changes in prey size/age structure, and changes in the composition of the marine community.

The listed species present in the action areas are presented in Section 3.3.4 of this document and bearded seals are discussed in Section 3.3.5. Below is the consultation history for Alternative 1, the fisheries as prosecuted under the existing FMP. The potential effects of Alternatives 2, 3, and 4 are described below. The Alaska Groundfish Fisheries Final Programmatic Supplemental EIS (NMFS 2004a) contains a complete discussion of the effects of the other fisheries in the BSAI on ESA listed species.

Crab fisheries are classified as a Category III fishery under the Marine Mammal Protection Act (MMPA). Placement in Category III is based on the level of serious injury and mortality of marine mammals that occurs incidental to that fishery. The NOAA Fisheries List of Fisheries for 1999, which reflects information on interactions between commercial fisheries and marine mammals, cites that one harbor porpoise was incidently killed/injured in all Alaska crustacean pot fisheries, which is an estimated 1,496 vessels (64 FR 9067). This incident occurred in Southeast Alaska, which is not part of the proposed action area for this environmental impact statement.

Effects of Alternative 1 on ESA listed marine mammals

The effects of Alternative 1 were analyzed in the Biological Assessment (BA) for the king and Tanner crab FMP. This BA analyzes the potential impacts of the crab fisheries on the listed species of marine mammals (NMFS 2000). NOAA Sustainable Fisheries submitted the BA to NOAA Fisheries Protected Resources as part of the informal Section 7 Consultation on the crab FMP. Plausible biological interactions between the crab fisheries and threatened and endangered species identified in the BA include competition for prey, changes in the composition and structure of the ecosystem, and disturbance. The BA found that, while such interactions are possible, the available evidence is not sufficient to argue persuasively that these hypothetical interactions do occur and limit the recovery of listed species occurring in the action area.

NOAA Fisheries Sustainable Fisheries Alaska Region reviewed the current status of the northern right whale, the bowhead whale, the blue whale, the fin whale, the sei whale, the humpback whale, the sperm whale, the western and eastern populations of Steller sea lions, the critical habitat designated for Steller sea lions, the environmental baseline for the action area, and the effects of the crab fisheries prosecuted under the FMP. NOAA Fisheries concluded that the actions considered in this BA are not likely to (1) result in the direct take or compete for the prey of the seven large protected whale species or the western and eastern population of Steller sea lions, or (2) destroy or adversely modify designated Steller sea lion critical habitat. NOAA Fisheries believes that the effects observed are insignificant or discountable under the ESA. NOAA Fisheries Protected Resources concurred with this determination (NMFS 2001a). Therefore, NOAA Fisheries concludes that the effects of Alternative 1 on listed marine mammals are insignificant under NEPA.

Effects of the rationalization program alternatives on ESA-listed marine mammals

The rationalization programs considered in this EIS allocate the crab fisheries resources to participants either through a three-pie voluntary cooperative program (Alternative 2), an IFQ program (Alternative 3), and a cooperative program (Alternative 4). These programs are designed to improve the effectiveness of the management of BSAI crab fisheries and reduce capacity in these fisheries. The predicted changes to the crab fisheries resulting from each alternative are described in Section 4.1.

The analysis of the effects of alternative is 2, 3, and 4 are organized around the two categories (operational and biological); the analysis will first address the operational and biological effects of the actions on the large protected whales and Steller sea lions. The last section analyses the effects of Alternative 2 on the Steller sea lion critical habitat. From the analysis presented below, NOAA Fisheries concludes that Alternatives 2, 3, and 4 would have an insignificant effect on ESA listed marine mammals. Additionally, based on the information below and in the Biological Assessment (NMFS 2000) prepared for the crab fisheries, NOAA Fisheries - Sustainable Fisheries determined, and Protected Resources concurred, that Alternative 2 is not likely to adversely affect the marine mammal species currently listed as endangered or threatened, or destroy or adversely modify critical habitat (NMFS 2004b).

Operational effects. For all seven species of large whales considered (northern right whale, bowhead whale, blue whale, fin whale, sei whale, humpback whale, and sperm whale), and Steller sea lions, plausible operational effects include ship strikes and gear entanglement.

Limited direct interactions between the fishery and marine mammals is most likely due to the nature of pot gear, the time of the crab fisheries (in the fall and winter), and the location of the fisheries (far from shore). Similarly, no ship strikes have been reported for vessels in the BSAI crab fisheries. Available data do not indicate direct interactions occur between the BSAI crab fisheries and the endangered and threatened species of marine mammals in the BSAI. Direct interactions are interactions between marine mammals and fishing vessels and pot gear, including buoy lines. Information on direct interactions comes from observer data, anecdotal accounts, and NOAA Fisheries Protected Resources Division. Observers report direct interactions between marine mammals and crab fishing vessels. Observers are instructed to take pictures of marine mammals and to report any interactions to NOAA Fisheries Protected Resources Division. From all of this information, no marine mammals have been reported to incur injury or mortality in the BSAI crustacean pot fisheries managed under the FMP. One exception was a humpback whale entanglement which is discussed in the BA. There have been no other reported interactions between marine mammals and crab vessels in this fishery, which indicates that such interactions are extremely rare. According to available information, this was a single occurrence and the whale was alive at the time it was released. Therefore, this entanglement has an insignificant effect on the humpback whale population. NOAA Fisheries will continue to monitor the fishery for humpback whale interactions. The rationalization program alternatives will not change the observer requirements to document and report marine mammal interactions.

NOAA Fisheries does not expect these patterns of entanglements or ship strikes to change under the alternative rationalization programs, and does not expect these alternatives to have adverse, operational effects on large whales or Steller sea lions.

Biological effects. The existing information suggests that the BSAI crab fisheries do not have a significant effect on the populations of any of the protected species of marine mammals. Information on biological effects comes from directed research, such as stomach analysis of marine mammals and study of the trophic interactions of crab. As shown below, crab are not a prey item of these marine mammals, and the crab fisheries do not remove significant amounts of any other species as bycatch from the ecosystem. Therefore, the removal of crab is not likely to alter the prey availability for protected marine mammals.

Plausible biological interactions include competition for prey, changes in the composition and structure of the ecosystem, and disturbance. Here too, while such interactions are plausible, the available evidence is not sufficient to argue persuasively that these hypothetical interactions do occur and limit the recovery of these species. Information on feeding habits indicates that northern right whales, bowhead whales, blue whales, fin whales, sei whales, and humpbacks forage primarily on prey lower in the food chain (e.g., zooplankton). Fin, sei, and humpbacks also prey on small schooling fishes including several species taken by the groundfish fisheries. No available evidence to date indicates that crab fisheries compete with these large whales or that the whales are limited by availability of prey. Sperm whales are deeper divers that rely primarily on mesopelagic prey (e.g., squid), and competition with the crab fisheries for prey is highly unlikely.

From migration patterns and distribution patterns of whale species it can be determined if a potential for disturbance exists. Northern right whales, blue whales, fin whales, humpback whales, are documented to occur in the action area in the summer months, thus, they are not present during the crab fisheries, which are prosecuted in the fall and winter. Sei whales and sperm whales generally occur in deeper waters than the fisheries operate and migrate to temperate and tropical waters in the fall and winter. The potential exists for fishery disturbance of bowhead whales by the snow crab fishery because it is prosecuted in the winter in the region of the southern winter distribution of these whales. However, again, the available evidence is not sufficient to argue that these hypothetical interactions do occur and limit the recovery of bowhead whales.

In review of the Biological Opinion (BiOp) on groundfish fisheries in the BSAI and GOA (NMFS 2000), which provides a partial listing of studies on the prey of Steller sea lions, crab are not a significant prey species. In fact, of the 20 studies summarized in the BiOp, only five studies list crab in the stomach contents, and, in each of these cases, crab were found in small amounts. An indirect linkage may exist from the fact that Steller Sea lions consume species that consume crab. However, the fishery may not significantly impact this linkage because most crab consumers eat larval crab, small crab, and molting females, none of which the fishery targets. The crab fisheries may have contributed to changes in the composition or structure of these ecosystems, but the nature of such hypothetical effects is not clear, if they occur.

Finally, these fisheries may increase the level of disturbance to marine mammals simply as a function of the number of vessels and the amount of gear present in areas that marine mammals might otherwise use. Potential exists for disturbance of Steller sea lions by the Aleutian Islands golden king crab fishery because a portion of the fishery occurs in the critical habitat around rookeries, haulouts, and associated areas. Here, too, this effect is at least hypothetically feasible, but cannot be meaningfully measured, detected, or evaluated with the information available.

NOAA Fisheries believes that disturbances by crab vessels cause an insignificant effect on large whales or Steller sea lions. The rationalization program alternatives are predicted to decrease the number of vessels operating in the crab fisheries, which would decrease any potential disturbance by vessels.

Effects on Steller sea lion critical habitat

The crab fisheries authorized under the crab FMP that occur, to some extent, in Steller sea lion critical habitat include Tanner crab, Bristol Bay red king crab, and golden king crab. Although the vast majority of these fisheries occur outside critical habitat. Plausible operational effects of these crab fisheries on critical habitat include gear placement and removal on the benthic habitat. Section 4.4 contains a complete description of the effects of pot gear on benthic habitat. From this analysis, and given the limited amount of crab fishing in critical habitat, NOAA Fisheries does not expect the crab fisheries under the rationalization program alternatives to adversely modify Steller sea lion critical habitat.

Effects of the alternatives on bearded seal

As discussed in Section 3.3.4, bearded seals do eat snow crabs, particularly in the winter. However, bearded seals are associated with sea ice, and, thus, forage on crabs in ice-covered areas. Snow crab fishermen avoid those ice-covered areas, eliminating the possibility of simultaneous competition. Although, there are times when fishermen fish close to the ice edge. Those areas are only seasonally ice-covered areas though, so fishermen could harvest crabs in those areas either before or after the ice was present. It is possible that the crab fishery could reduce crab stocks in the central and northern Bering Sea and thereby reduce the prey available to bearded seals. This competition, however, would be limited to seasonally ice-covered areas on the continental shelf, based on scientific information that bearded seals are strongly associated with sea ice and shallow waters. In addition, the potential effects of this fishery on bearded seals is mitigated by the snow crab harvest strategy that only allows removals of approximately 20 percent of legal-sized males and prohibits harvest of females. Any effects of the snow crab fishery on the bearded seal population cannot be discerned. Therefore, it is conclude that the crab fisheries do not significantly effect bearded seals.

The rationalization program alternatives would not encourage fishermen to fish closer to the ice edge. Without the race to fish, incentives would exist to reduce costs, which would include reducing gear loss. This may provide an incentive to avoid the ice edge. It is assumed the effects of Alternatives 2, 3 and 4 will be similar to status quo and we conclude that these alternatives would have an insignificant effect on bearded seals.

4.3.3 Seabirds

The U.S. Fish and Wildlife Service (USFWS) identified the following possible ways in which eiders or their habitat may be affected by commercial fisheries: (1) large numbers of small fuel and oil spills, including the practice of discharging oily bilge water; (2) fundamental changes in the marine ecosystem brought about by harvest or overharvest of fish and shellfish; (3) vessel strikes in which eiders collide with fishing vessels that are using bright lights during inclement weather; and (4) the alteration of the benthic environment by trawling gear (66 FR 9146). This assessment analyses the effects of these possible interactions between listed species and the crab fisheries as implemented under each alternative.

Table 4.3-6 Significance table for seabirds. Criteria for determining the significance of direct and indirect effects of the BSAI king/Tanner crab fishery on seabirds: significant adverse (S-), insignificant (I), or unknown (U).

Effects	Score		
	S-	I	U
1. Vessel pollution	Level of pollution likely to have population level effect on species.	Level of pollution unlikely to have population level effect on species.	Insufficient information available on pollution levels or toxicological effects on species.
2. Ecosystem Changes	Food availability decreased such that seabird survival or reproductive success is likely to decrease.	Food availability such that seabird survival or reproductive success is likely not affected.	Insufficient information available on abundance of key prey species or the scope of fishery impact on prey.
3. Incidental take in gear and vessel strikes	Level of take likely to delay recovery or result in a population decline.	Level of take not likely to have population level effect on species.	Insufficient information available on take rates or population levels.
4. Benthic or critical habitat	Adverse modification of habitat such that seabird survival or reproductive success is likely to decrease.	Impact to habitat unlikely to change seabird survival or reproductive success.	Insufficient information on the scope of habitat impacts.

Table 4.3-7 Summary table of effects of each alternative on seabirds.

Effect	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Vessel pollution	I	I	I	I
Ecosystem Changes	I	I	I	I
Incidental take in gear and vessel strikes	I	I	I	I
Benthic or critical habitat	I	I	I	I

The key questions in evaluating the potential effects of the actions under the FMP on populations of listed seabirds are: (1) whether the fisheries conducted under these actions impact listed species through trophic (food web) interactions, and (2) whether the fishing methods and gear deployed take listed seabirds or adversely modify critical habitat. Due to the fact that some of the crab fisheries operate in sea bird critical habitat, an analysis of these actions on critical habitat is also necessary. Important to determine are (1) do these effects occur or could they occur under each alternative, and (2) if they do occur, do they occur to an extent that would limit the recovery of a listed species or adversely modify critical habitat. If these effects do occur to an extent that would limit the recovery of a listed species or adversely modify critical habitat, then it could be concluded that the action would have significant effects on the listed species under NEPA. If these effects do not occur or are insignificant, then it could be concluded that the action would have insignificant effects for the purpose of this NEPA analysis.

The USFWS identified commercial fisheries as an activity that may have the potential to destroy or adversely modify critical habitat for spectacled eiders and Steller's eiders (66 FR 9146, 66 FR 8850). In the action area, critical habitat has not been designated for short-tailed albatross. However, for spectacled eiders, the USFWS believes "that direct interactions with the commercial fisheries does not seem to be a problem for this species" (66 FR 9146).

Effects of Alternative 1 on Endangered Species Act-listed seabirds

In 1994, NOAA Fisheries prepared a BA for the king and Tanner crab FMP, which analyzed the potential takes of listed seabirds in these fisheries and conducted an informal Section 7 Consultation with USFWS (NMFS 1994). According to the BA, the crab fisheries are not known to result in any significant impact to the short-tailed albatross, Steller's eider, or spectacled eider. Nor do the fisheries compete for any crab species commonly preyed upon by marine birds. NOAA Fisheries determined that the crab fisheries will have no adverse impact on any listed seabird nor will they delay in any way the recovery of those species, except the snow crab fishery which may adversely impact the spectacled eider. This determination lead to formal Section 7 Consultations between NOAA Fisheries and USFWS to determine the effects of the snow crab fishery on the spectacled eider.

The snow crab fishery was the only crab fishery under the FMP that NOAA Fisheries and USFWS determined through informal consultation had the potential to impact spectacled eiders. Spectacled eider, a threatened seaduck, feed on benthic mollusks and crustaceans taken in shallow marine waters or on pelagic crustaceans. The marine range for spectacled eider is not known, although Dau and Kitchinski (1977) review evidence that they winter near the pack ice in the northern Bering Sea. Spectacled eider are rarely seen in United States waters except in August through September when they molt in northeast Norton Sound and in migration near St. Lawrence Island. The lack of observations in United States waters suggests that, if not confined to sea ice polyneas (ice islands), they likely winter near the Russian coast (USFWS 1993).

Between 1994 and 1998, NOAA Fisheries consulted with the USFWS annually on the crab FMP, which includes the winter Bering Sea snow crab fishery, pursuant to Section 7 of the ESA (USFWS 1996a and 1996b). In the past, Section 7 Consultations on this fishery have been formal because it was perceived that the fishery was likely to adversely affect spectacled eiders. This perception of a likelihood of an adverse effect resulted from: (1) a lack of knowledge concerning the at-sea range of spectacled eiders and; (2) a lack of knowledge of the species of eiders that have struck, or were likely to strike crab vessels.

Beginning in 1995, observers aboard crab vessels received training in bird identification and reporting. Observers were instructed to report all sightings of spectacled eiders to the USFWS either directly or through ADF&G. To date, no take of spectacled eiders associated with this fishery has been reported.

Since the initial determination that the snow crab fishery was likely to adversely affect spectacled eiders, the USFWS has learned much about the at-sea distribution of spectacled eiders. Satellite telemetry data and three years of late-winter aerial surveys indicate that spectacled eiders spend the winter in exposed waters between St. Matthew and St. Lawrence Islands, or in open leads slightly west of the inter-island area. Snow crab fishing has been largely concentrated around the Bering Sea continental shelf, which in the Bering Sea, runs from Unimak Island to the northwest, passing well south and west of St. Matthew Island. Crab fishing occurs along the shelf because this is where the greatest snow crab concentrations occur, and not because of fishing ground access restrictions imposed by sea-ice conditions between January and March. Thus, even if sea ice conditions were to make it possible for crab vessels to venture into the waters used by wintering spectacled eiders, they would not likely do so, due both to the time and expense of vessels traveling that far and the relatively low number of snow crabs present there.

Therefore, in 1998, USFWS concurred with the NOAA Fisheries determination that the snow crab fishery is not likely to adversely affect threatened or endangered species under the jurisdiction of the USFWS, including the threatened spectacled eider (USFWS 1998a). Crab fishery observers will continue to be placed aboard the CVs participating in this fishery, and in the future, these CV observers will continue to receive training and refresher training in seabird identification and seabird reporting procedures.

In February 2001, USFWS designated critical habitat for Steller's eider and spectacled eider, thus requiring reinitiating the Section 7 Consultation under 50 CFR Section 402.16. The USFWS published the final determination of critical habitat for the spectacled eider and Alaska-breeding population of the Steller's eider (66 FR 9146, 66 FR 8850).

NOAA Fisheries prepared a BA for the BSAI crab FMP that assesses the effects of the crab fisheries on these seabirds and their critical habitat (NMFS 2002). The BA identified how BSAI crab fisheries may affect, directly or indirectly, seabird populations and critical habitat. Potential direct effects, as identified by USFWS, are vessel pollution and vessels strikes. Potential indirect effects, also identified by USFWS, are ecosystem changes and alteration of benthic habitat. Cumulative effects include non-federal fisheries, subsistence, and marine pollution. USFWS identified these potential effects for all fisheries. From this analysis, the BA identified that the only plausible biological interaction between the crab fisheries and threatened and endangered species is vessel strikes by seabirds. While such interactions are possible, the available evidence is not sufficient to argue persuasively that these interactions do occur in today's fisheries to an extent that limits the recovery of listed species occurring in the action area. After reviewing the current status of the short-tailed albatross, the spectacled eider, and Steller's eider, the critical habitat designated for the spectacled eider and Steller's eider and the potential effects of the crab fisheries prosecuted under the FMP, NOAA Fisheries concluded that the actions considered in the BA are not likely to (1) adversely affect the listed seabirds, or (2) destroy or adversely modify designated critical habitat. USFWS concurred with this determination on January 13, 2003 (USFWS 2003). Based on this analysis and determination, NOAA Fisheries concludes that the effects of status quo on listed seabirds are insignificant under NEPA.

Effects of rationalization program alternatives on Endangered Species Act-listed seabirds

From the analysis presented below, NOAA Fisheries concludes that each of the rationalization program alternatives would have an insignificant effect on listed seabirds. Additionally, based on the information below and in the Biological Assessment (NMFS 2002a) prepared for the crab fisheries, NOAA Fisheries - Sustainable Fisheries determined, and the USFWS concurred, that Alternative 2 is not likely to adversely affect the seabird species currently listed as endangered or threatened, or destroy or adversely modify critical habitat (NMFS 2004c, USFWS 2004).

The first step in determining the effects of the proposed changes to the crab fisheries is to determine if the proposed action will cause an increase in fishing in spectacled eider and Steller's eider critical habitat. It is not likely that the crab fisheries would increase in critical habitat under any of the alternatives. Crab fisheries occur in areas of high abundance of legal male crabs. From the survey data, we can determine that crab are not concentrated in designated critical habitat for either species, except in Norton Sound. A portion of Norton Sound is critical habitat for spectacled eiders. The Norton Sound is excluded from the rationalization program alternatives.

Between 1990 and 2000, a few vessels targeting snow crab have fished the winter habitat area for spectacled eiders. Due to State confidentiality laws, years in which fishing occurred cannot be disclosed because less than four vessels fished in each of the five statistical areas over the 10-year time period. Note that two of the five statistical areas are only partially in critical habitat, so that the fishing could have occurred outside critical habitat. Alternatives 2, 3 and 4 would not provide incentives to move fishing into this area of critical habitat. The crab fisheries will continue to be observed at the location of harvest, so that determinations can be made as to where the fisheries occur under the new management structure and will be able to monitor if fishing effort increases in critical habitat. Additionally, the rationalization program alternatives may necessitate the State to increase observer coverage for the crab fisheries, which would improve data collection and information on fishery interactions with seabirds.

Vessel pollution. USFWS identified the occurrence of a large number of small fuel and oil spills, including the practice of discharging oily bilge water, as possible ways in which spectacled eiders and Steller's eiders or their habitat may be adversely affected by commercial fisheries. USFWS identified damage or injury to short-tailed albatross related to oil contamination as a potential threat to its conservation and recovery. Available information on the effects of oil spills caused by fishing vessels in the BSAI is summarized in the Alaska Groundfish Fisheries Final Programmatic Supplemental EIS (NMFS 2004a).

No information is available to determine if the BSAI crab fleet causes a large number of small fuel and oil spills in the action area. Fishing vessels report fuel and oil spills to the U.S. Coast Guard (Lt. Joe Higgins, Marine Safety Office, U.S. Coast Guard, personal communication to Gretchen Harrington, NOAA Fisheries). Observers are also tasked with reporting oil spills to the Coast Guard. The Coast Guard does not categorize vessels by which fishery they participate in, instead it categorizes them by vessel size. Therefore, oil spills caused specifically by crab vessels cannot be determined.

Steller's eider critical habitat. It is not likely that the small amount of effort (2 percent of vessel landings in 1998, 0.5 percent of pounds harvested of red king crab) near the Nelson Lagoon unit would pose a threat for a large amount of fuel and oil spills. In addition, the Bristol Bay red king crab fishery, which is the only crab fishery near Nelson Lagoon, occurs in the last two weeks of October, when the majority of Steller's eiders have migrated out of Nelson Lagoon.

Spectacled eider critical habitat. It is not likely that the small amount of red king crab fishery effort (less than 2 percent of total harvest from 1977 to 1999) near critical habitat in Norton Sound would pose a threat for a large amount of fuel and oil spills. The near shore area, which is the majority of critical habitat, is closed to fishing and a limited amount of fishing occurs in the adjacent statistical areas, a portion of which are critical habitat. However, fishing does occur from July to September, the months that USFWS identified when spectacled eider are particularly susceptible to disturbance and environmental perturbations.

It is not likely that the small amount of snow crab fishery effort in the winter habitat area would pose a threat for a large amount of fuel and oil spills. In the period between 1990-2000, less than four vessels fished in each of the five statistical areas in critical habitat.

Short-tailed albatross. It is not likley that the lawful operation of BSAI crab fisheries would cause oil contamination to short-tailed albatross.

Three factors are important in analyzing the effects of fuel spills; what type of fuel/oil is spilled, how much, and where it spilled. The key questions are whether the increased potential exists for a large number of fuel and oil spills in or near designated critical habitat with the implementation of Alternatives 2, 3, or 4. And, whether the increased potential exists for the BSAI crab vessels to cause oil contamination of short-tailed albatross.

The rationalization program alternatives are not predicted to increase effort in areas of critical habitat. In fact, implementing any of the rationalization program alternatives may decrease effort in all areas, including critical habitat because these rationalization programs are predicted to decrease the number of vessels operating in the crab fisheries. This decrease in effort would decrease the potential for fuel and oil spills.

Ecosystem changes. USFWS identified fundamental changes in the marine ecosystem brought about by harvest or overharvest of fish and shellfish as a potential threat to listed seabirds and their critical habitat. Plausible biological interactions include competition for prey and changes in the composition and structure of the ecosystem. Information on biological effect comes from directed research, such as prey studies of seabirds and studies of the trophic interactions of crab. The existing information suggests that the BSAI crab fisheries do not have a significant effect on the populations of any listed species of seabirds. No evidence indicates that the crab fisheries fundamentally change the ecosystem. A complete discussion of the predicted effects of the alternative rationalization programs on the ecosystem is in Section 4.5. In that section, NOAA

Fisheries concludes that these alternatives would not change the crab fisheries in a manner that would change how the fisheries effect the ecosystem.

Harvest of crab by the fisheries would have a direct effect on listed seabirds or critical habitat if seabirds competed with the fisheries for prey. Information on spectacled eider feeding habits indicates that they spend most of the year in marine waters where they primarily feed on bottom-dwelling molluscs and crustaceans at depths up to 70 meters. Steller's eiders inhabit nearshore marine waters, where they feed by diving and dabbling (bobbing head underwater to fee off the bottom) for mollusks and crustaceans. Albatrosses are surface feeders, which feed principally on small fish (e.g., larval and juvenile walleye pollock and sablefish), squid, and zooplankton, much of which is presumed to be of little commercial interest. Crab, at the size and location targeted by the fishery, are not a prey item of these seabirds, and the crab fisheries do not remove significant amounts of any other species as bycatch from the ecosystem. Most crab consumers eat larval crab, small crab, and molting females, none of which the fishery targets. Therefore, the removal of crab by the fishery is not likely to alter the prey availability for listed seabirds. Thus, no available evidence to date indicates that crab fisheries compete with these seabirds or that the seabirds are limited by availability of prey.

Harvest of crab by the fisheries would have indirect effects on listed seabirds or critical habitat if the fisheries change the composition or structure of the ecosystem. The crab fishery harvests may have contributed to changes in the composition or structure of the ecosystem, but the nature of such hypothetical effects is not clear, if they occur. Under the FMP, overharvest is prevented by the overfishing parameters which close crab fisheries at low abundance levels and rebuild the stocks. Alternatives 2, 3 and 4 would not change the overfishing parameters. Removal of crabs by the fisheries under these alternatives is not expected to cause trophic-level (food web) interactions impacting the prey consumed by listed seabirds.

From the available information, it is impossible to determine whether indirect take of short-tailed albatrosses resulted from ecosystem perturbations caused by this action. In the Section 7 Consultation for the Pacific halibut fisheries, USFWS stated that "because the population on Torishima Island appears to be increasing at near maximum biological potential, it seems that this species is not limited by food quantity or quality. Therefore, the USFWS concludes that indirect take resulting from changes in the marine trophic system that may have been caused by this fishery is negligible and discountable" (USFWS 1998b). This same reasoning is applied to the fisheries under Alternatives 2, 3 and 4 and concludes that indirect take resulting from changes in the marine trophic system (food relationships of different organisms), that may have been caused by this fishery, is negligible and discountable.

Vessel strikes. Vessel strikes can be assessed because fishery observer programs have generated substantial information on operational interactions between seabirds and fisheries. In addition, from known migration and distribution patterns of listed seabirds, it can be determined if a potential for vessel strikes exists. Direct interactions between seabirds and crab fishing vessels are reported by observers. Since 1995, observers on crab vessels have received annual training in bird identification and reporting, and have reported all observations to the USFWS through the ADF&G office in Dutch Harbor. The general public, through a voluntary reporting program, also reports seabird interactions to USFWS. NOAA Fisheries does not expect an increase in the frequency of vessel strikes by seabirds under Alternative 2, 3, and 4. In fact, the potential for vessel strikes may decrease as the number of vessels that participate in the fisheries decreases. No behavioral changes that would increase the likelihood of vessels strikes are predicted.

The Section 7 Consultation between NOAA Fisheries and USFWS from 1994 to 1998 focused on the potential for vessel strikes by spectacled eiders in the snow crab fishery. The snow crab fishery was the only crab fishery under the FMP that NOAA Fisheries and USFWS determined through informal consultation had the potential to impact listed seabirds. As a result of this finding, formal Section 7 Consultations were made to determine the effects of the snow crab fishery on the spectacled eider. This perception of a likelihood of an adverse effect resulted from: (1) a lack of knowledge concerning the at-sea range of spectacled eiders and; (2) a lack of knowledge of the species of eiders that have struck, or were likely to strike crab vessels (USFWS 1998a).

The 1994 BiOp explains that spectacled eiders may strike snow crab fishing vessels because the birds are disoriented by the bright lights (USFWS 1994). The 1994 BiOp references anecdotal information citing eiders (species not determined) striking lighted crab fishing vessels. USFWS prepared an incidental take statement estimating that no more than ten spectacled eiders can be incidentally taken (as reported by observers or volunteers). The statement prescribes that NOAA Fisheries insure that ADF&G implement the observer and reporting requirements described in the BiOp as reasonable and prudent measures. The observer and reporting requirements require that incidental bird take reports from trained fishery observers shall be forwarded to USFWS. In January 1998, USFWS concluded the formal consultation because no take of spectacled eiders associated with the snow crab fishery had been reported between 1994 and 1998.

Beginning in 1995, observers aboard crab vessels received training in bird identification and reporting. Observers were instructed to report all sightings of listed seabirds to the USFWS either directly or through ADF&G. To date, no take of spectacled eiders associated with this fishery has been reported. ADF&G continues to place crab fishery observers aboard the C/P vessels, and is now placing observers on a portion of CVs participating in this fishery, and these observers continue to receive training and refresher training in seabird identification and seabird reporting procedures.

Since the initial determination that this fishery was likely to adversely affect spectacled eiders, the USFWS has learned much about the at-sea distribution of spectacled eiders. Satellite telemetry data and three years of late winter aerial surveys indicate that spectacled eiders spend the winter in exposed waters between St. Matthew and St. Lawrence Islands, or in open leads slightly west of the inter-island area. Snow crab fishing has been largely concentrated around the Bering Sea continental shelf, which in the Bering Sea, runs from Unimak Island to the northwest, passing well south and west of St. Matthew Island. Crab fishing occurs along the shelf because this is where the greatest snow crab concentrations occur, and not because of fishing ground access restrictions imposed by sea-ice conditions between January and March. Thus, even if sea ice conditions were to make it possible for crab vessels to venture into the waters used by wintering spectacled eiders, they would not likely do so, due both to the time and expense of vessels traveling that far and the relatively fewer number of harvestable snow crabs present there. Therefore, in 1998, USFWS concurred with the NOAA Fisheries determination that the snow crab fishery is not likely to adversely affect, through vessel strikes, threatened or endangered species under the jurisdiction of the USFWS, including the threatened spectacled eider (USFWS 1998a).

Since the conclusion of the formal consultation, there have been no reports that indicate vessel strikes of the endangered and threatened species of seabirds by BSAI crab vessels. Information on vessel strikes comes from observer data, anecdotal accounts, and USFWS. From these information sources, no endangered or threatened seabird species have been reported to incur injury or mortality in the BSAI crab pot fisheries managed under the FMP since the conclusion of the previous consultation. Observer training and reporting requirements will not change under any of the rationalization program alternatives. In fact, under these alternatives the potential for vessels strikes may decrease as the number of vessels in the crab fisheries decreases. On the other hand, this decrease may be offset by the potential increase in the amount of time each vessel spends fishing.

Alteration of benthic habitat. Alteration of benthic habitat is discussed in Section 4.4. Given the limited amount of crab fishing that occurs in seabird critical habitat, and the fact this effort is not expected to increase, combined with our understanding of the effects of pot gear on the benthic environment, NOAA Fisheries does not expect the crab fisheries under any of these alternatives to adversely modify spectacled eider or Steller's eider critical habitat or to adversely affect any of the listed seabird species. Section 4.6.1.3 explains the effects of the rationalization program alternatives on the level of effort and capitalization in the crab fisheries.

4.3.4 Physical environment in vicinity of processors

Discharge into marine waters of organic waste from land-based fish processing facilities as well as processing vessels operating at-sea has occurred as long as fishing has occurred in Alaskan waters. Effects of the discharge are best evaluated in terms of (1) location and rate of nutrients returned to the marine environments and (2) effects on or changes to the ambient water quality parameters in the locations where they are returned. Section 3.3.6 contains a complete description of the environment in the vicinity of crab processors.

Table 4.3-8 Significance table for the physical environment in vicinity of processors. Criteria for determining the significance of direct and indirect effects of the BSAI king/Tanner crab fisheries on the physical environment in vicinity of processors: significant adverse (S-), insignificant (I), or unknown (U).

Effects	Score		
	S-	I	U
1. Accumulation of benthic waste	Processing waste accumulation exceeds discharge permit.	Processing waste in compliance with discharge permit.	Insufficient information available on magnitude processing waste.
2. Concentration of biochemical oxygen demand (BOD).	Concentration of BOD in excess of permit allowance.	Concentration of BOD in compliance of permit.	Insufficient information available on magnitude of BOD concentration.
3. Discharge of suspended solids.	Discharge of suspended solids in excess of permit requirements.	Discharge of suspended solids in excess of permit requirements.	Insufficient information available on magnitude of discharge of suspended solids.

Table 4.3.-9 Summary table of effects of each alternative on the physical environment in vicinity of processors.

Effect	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Accumulation of benthic waste	I	I	I	I
Concentration of biochemical oxygen demand (BOD)	I	I	I	I
Discharge of suspended solids	I	I	I	I

The U.S. Environmental Protection Agency (EPA) has identified the major components of seafood processing wastes as blood, tissue, liquids, meat, viscera, oil and grease, shells, bones, and chlorine (EPA 1994). These wastes are primarily organic matter that are, except for the bones and shells, highly biodegradable. Major pollutants consist of total suspended solids, oil and grease, and biochemical oxygen demand (BOD). These major pollutants are all considered conventional and are of a non-toxic nature. Smaller concentrations of chlorine, ammonia, and fecal coliform bacteria may also be present. The EPA summarized the potential water quality impacts as follows (EPA 1994):

Organic seafood wastes can exert a large BOD in receiving waters. This is a critical issue in seafood waste disposal since the BOD of the effluent (discharge of liquid waste) stream is the basis for estimating the dissolved oxygen which will be consumed as the wastes are degraded. It is possible to reach conditions where the dissolved oxygen in the water is totally used up, resulting in anaerobic (absence of oxygen) conditions and the production of undesirable gases such as hydrogen sulfide and methane. Emission of these gases has been observed in seafood processing centers, such as Dutch Harbor, in sufficient quantities to form bubbles and cause skin and eye irritation to divers. The reduction of dissolved oxygen can be detrimental to fish populations, fish growth rate, and organisms used as fish food. The total lack of oxygen can also result in the death of all aerobic aquatic inhabitants in the affected areas. Water with high BOD also has increased bacterial concentrations which degrade water quality.

The total suspended solids in seafood processing waste will include both organic (grease, oil, seafood waste) and inorganic (sand and shell fragments) materials. These solids may settle out rapidly or remain in suspension for a time prior to settling. Solids may either be inert, slowly degradable substances or rapidly decomposable materials. While in suspension they increase the turbidity (cloudiness) of the water, reduce light penetration, and impair the photosynthetic activity of aquatic plants. Suspended solids may kill fish or shell fish by causing abrasive injuries, by clogging gills and respiratory passages, screening out light, and promoting the development of noxious conditions through oxygen depletion.

There appear to be three zones of impact associated with seafood waste discharge (Pearson and Rosenburg 1978). In the first zone the impacts are readily observable, with non-mobile benthic life being smothered as the wastes accumulate in easily identified waste piles. Recolonization of these areas will not occur at active discharge sites and may not occur for several years after discharge has ceased.

The second zone of impact lies outside of the immediate zone of accumulation. It is probable that this zone is dynamic, changing in size and impact with respective environmental conditions. Organisms residing in this second zone may be exposed to the smothering effects of accumulated wastes as well as environmental degradation from increased suspended solids, turbidity, color and hydrogen sulfide, and decreased dissolved oxygen. Smothering in this zone is caused by the less dense, fleshy waste materials and slurry as they slowly settle after being transported by the prevailing currents. In the secondary zones recolonization may occur, but is limited by the availability of the suitable attachment surfaces and recurrence of stressful conditions.

The third zone of impact lies outside of the zones of primary, persistent accumulation and secondary, intermittent accumulation. The third zone is a zone of enrichment, wherein the benthic community may be more diverse and productive than typical of an area due to the benefits of increased supplies of food and nutrients in amounts which do not exceed the assimilative capacity of the sea floor and organisms there.

Aesthetic effects can occur from the discharge of seafood processing wastes, especially in concentrated processing areas. Water discoloration, floating solids, scum and foam may be observed if adequate flushing is not available or if outfall (discharge) lines are not operating properly. These may cause a nuisance by accumulating in fishermen's nets or on beaches or shorelines.

Effects of Alternative 1

All crab waste is biodegradable. The size of the particles discharged, and whether it is ground into fine particles before discharge or discharged whole, is the primary determinant of the path it takes back into the marine food chain. Other determinants are a function of the location, depth, and circulation patterns of receiving waters, and the species of opportunistic feeders present near the discharge. Many observations have documented large chunks of waste being consumed by opportunistic predators soon after discharge. The opportunistic predators include species of invertebrates, fish, birds, and marine mammals.

Scavenging seabird species such as northern fulmars and large gulls are well-known consumers of fish processing waste. Though the food source may appear to benefit populations of some species, such as gulls, it can be detrimental to species displaced or preyed upon by the increased population of gulls (Furness and Ainley 1984).

In order to control discharge and prevent occurrences of over-enrichment in localized areas, discharge is regulated under the Clean Water Act (Section 402). Under this Act, National Pollutant Discharge Elimination System (NPDES) permits are issued by the EPA. Most at-sea floating processors apply for and receive NPDES permits authorizing them to discharge fish waste with the stipulation that the waste be ground into finer than one-half inch particles and discharged below the surface. The intent of the stipulation is to avoid quantities of organic materials accumulating in a confined waterbody to the degree that during decomposition it consumes so much of the available dissolved oxygen that oxygen depletion of the surrounding waters occurs. If depletion of oxygen were to occur in the short term, it could result in mortality of invertebrates, such as crab. Long term changes in species composition of the area occur as the species with lower tolerances for anoxic waters move away.

Unauthorized organic discharge is generally understood to mean accumulations of dead fish, crab shells, and/or fish waste material that either smother the bottom or impair the surrounding water quality to such a degree that viability of marine species is compromised. Observations of this in Alaska are undocumented, though anecdotal accounts abound.

The point source discharges from established onshore processing operations in ports (e.g., Kodiak, Dutch Harbor, St. Paul, and Akutan) are also subject to Clean Water Act permitting requirements. Each permit application is evaluated in an open, public forum when it is being considered for issuance by the EPA, and it remains subject to EPA's oversight. Some facilities in locations, such as Captains Bay near Dutch Harbor, are required to collect waste streams and to barge it several miles offshore prior to discharge.

Using the Clean Water Act, the Alaska Department of Environmental Conservation established total maximum daily load limits for Udagak Bay (Beaver Inlet on Unalaska Islands in the Aleutian Islands) and King Cove lagoon in King Cove (on the Alaska Peninsula in the Aleutians East Borough) because of the effects of seafood wastes on water quality in those waterbodies (EPA 1998a and 1998b).

While the impacts of inshore processing wastes on localized water bodies is a potential area of concern, NOAA Fisheries believes that existing EPA oversight over processing waste discharges under the Clean Water Act are adequate to prevent significant impairment of nearshore water quality or the nearshore benthic environment. Crab processing waste under status quo is described in Section 3.3.6. From this analysis and the information presented in this section, NOAA Fisheries concludes that the effects of status quo on nearshore water quality and nearshore benthic environments are considered to be insignificant.

Effects of Alternatives 2, 3, and 4

Under the rationalization program alternatives, the total amount of crab processed by the shore-based processors will remain the same because they will not increase the total amount of catch. Concomitantly, inshore discharges of processing wastes would not increase. Alternatives 2 and 3 contain measures to ensure that each region, the north and the south, processes its historic portion of the crab harvest. However, within regions, the amount of crab processed by each community may change as processors consolidate and reduce excess capacity. Under Alternative 4, the harvest allocations will not be regionalized. This may result in increases in discharge from some processors and decreases in discharge from other processors as landings shift.

In addition, under each alternative to status quo, Adak, a community that does not have a long history of crab processing, would be allocated a large portion of processor quota for processing brown king crab. As a result, crab processing will increase in Adak. This will result in an increase in discharge of crab waste. However, this increase will still need to comply with the processor's NPDES permit. Therefore, NOAA Fisheries concludes that this increase in discharge in Adak would have insignificant effects on water quality and substrate.

In addition, the elimination of the race for fish is likely to lead to longer fishing seasons meaning that point source discharges of seafood processing wastes are likely to occur during longer periods of time. Processors will potentially receive a steady stream of crab throughout the extended season as opposed to pulses of crab and will have the flexibility to spread out crab deliveries and processing activity to distribute pollutant discharges of BOD, oil and grease, solid processing wastes, and nutrients over longer time periods in inshore bays.

The worst time to discharge is between mid-July and mid-September when the water column is stratified by a summer pycnocline (water separated by density) (H. Burney Hill, EPA Region 10, personal communication to Gretchen Harrington, NOAA Fisheries). This time coincides with the biologically sensitive periods for most species of crab. Crab fisheries are prohibited during the biologically sensitive periods and, since the crab undergo molting during this time period, they are not of a marketable quality until a couple of months after this period, so it is reasonable to assume that very little crab will be processed between mid-July and mid-September. The crab species most likely to be processed during this time is Aleutian Islands golden king crab. Under status quo, the Aleutian Islands golden king crab fishery opens August 15 and it is reasonable to assume that it will continue to open at that time under all alternatives. Under Alternatives 2, 3, and 4, landing and processing of golden king crab will be divided between Dutch Harbor and Adak.

The processor quota element of Alternative 2, the three-pie voluntary cooperative, provides inshore processors with significantly greater flexibility to comply with EPA-mandated water quality requirements through slowing the pace of processing and scheduling processing for time periods when water conditions are most optimal for dispersion of processing waste discharge. In addition, the potential increase in recovery of crab meat possible under this proposed program means that inshore processors may have less solid crab waste to discharge per metric ton of crab processed than under the no-action alternative. Furthermore, the increased profitability of the inshore sector with processor quota should mean that inshore processors are in a better position to deploy best available technologies to treat and reduce processing waste. These same benefits could be expected from the cooperative alternative because processors would have the ability to coordinate deliveries with harvesters to achieve these benefits. However, the IFQ program is not predicted to provide greater flexibility to processors because it does not provide for processors to determine when deliveries should occur. The IFQ program would provide for a slower pace for processing because harvesting would occur at a slower pace. Therefore, the reductions in discharge expected under the IFQ program are less than the reductions expected under Alternatives 2 and 4.

With respect to the environmental impacts of the alternatives, the amount and type of daily effluent discharge allowed under each processor's NPDES permit would not change and the cumulative amount would not increase. Under an NPDES permit, effluent discharges, waste piles on the sea floor, residues on the sea surface and shoreline, and ambient water quality (especially dissolved oxygen) are monitored to ensure compliance with the permit.

NOAA Fisheries believes that the existing EPA oversight over processing waste discharges under the Clean Water Act is adequate to prevent significant impairment of nearshore water quality or the nearshore benthic environment. Crab processing will not increase during critical time periods for water quality. To be precautionary, continued monitoring of water quality and waste residues around crab processing plants is necessary to ensure that significant degradation of water quality and habitat does not result from implementation of any of the alternatives to status quo. Therefore, the effects of Alternatives 2, 3 and 4 on nearshore water quality and nearshore benthic environments are considered to be insignificant provided that monitoring continues and NPDES permits are reviewed on a timely basis to ensure that any increases in processing activity do not degrade nearshore water quality and benthic habitat.

4.3.5 Non-Indigenous Species

The NOAA Administrative Order 216-6, the environmental review procedure for implementing NEPA, requires that an EIS analyze whether the proposed action may result in the introduction or spread of a non-indigenous species. Due to the nature of this proposed action, to rationalize the BSAI crab fishery, none of the alternatives would result in the introduction or spread of a non-indigenous species. Available information indicates that the current BSAI crab fishery has not resulted in the introduction or spread of non-indigenous species.

4.4 Essential fish habitat assessment

Section 4.4 addresses the mandatory requirements for an EFH assessment enumerated in the Final Rule (67 FR 2343, January 17, 2002) implementing the EFH provisions of the Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267). An EFH assessment is prepared for any federal action that may adversely affect EFH. These requirements are:

- a description of the action;
- an analysis of the potential adverse effects of the action on EFH and the managed species;
- the federal agency's conclusions regarding the effects of the action on EFH; and
- proposed mitigation, if applicable.

An EFH assessment may incorporate by reference other relevant environmental assessment documents, such as a BA, another NEPA document, or an EFH assessment prepared for a similar action.

EFH is defined in the Magnuson-Stevens Act as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." (16 U.S.C. 1802 Sec. 3, 104-297). The Final Rule defines adverse effect as any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

The area affected by the proposed action has been identified as EFH for all of the FMP managed species in the BSAI. EFH for these species is described and identified in four FMP amendments which were approved January 20, 1999. These are: Amendment 55 to the FMP for the Groundfish Fishery of the BSAI Area; Amendment 8 to the FMP for BSAI King and Tanner Crabs; Amendment 5 to the FMP for Scallop Fisheries off Alaska; and Amendment 5 to the FMP for the Salmon Fisheries in the Exclusive Economic Zone off the Coast of Alaska. NOAA Fisheries and the Council are currently developing an EIS to analyze alternative definitions for EFH for the FMP managed species in the Alaska Region (NMFS 2004d).

4.4.1 Description of the action

The actions considered in this EFH assessment are the EIS alternatives; status quo, a three-pie voluntary cooperative (Alternative 2), an IFQ program (Alternative 3), and a cooperative program (Alternative 4). These alternatives are described in detail in Chapter 2. The important components of these alternatives for the EFH assessment are the gear used, the fishing effort (pot lifts), the location of the fishery, and the timing of the fishery. Descriptions of the crab fisheries are in Section 3.4, this section provides a description of the gear used and habitat types where these fisheries occur. The benthic habitat and species impacted by pot gear is detailed in Sections 3.3.1 and 3.3.2, and the effects of the alternatives on benthic habitat and species is analyzed in Sections 4.3.1. The changes to the prosecution of the fisheries predicted to result from the alternatives are described in Section 4.1. In summary, the rationalization program alternatives would change the fisheries in the following ways: fishing effort would decrease to the level necessary to harvest the TAC; the general location of the fishery would stay the same, however, the intensity in specific locations would decrease; the fishing season would expand, however, fishing would still be prohibited during each species biologically sensitive period. The gear used in the fishery would not change under the alternatives.

4.4.2 Analysis of the potential adverse effects of the action on essential fish habitat and the managed species

Summaries and assessments of habitat information for BSAI king and Tanner crab are provided in the "Essential Fish Habitat Assessment Report for the Bering Sea and Aleutian Islands King and Tanner Crabs" dated March 31, 1998 (NPFMC 1998d). The evaluation of the potential adverse effects of crab fishing activities conducted under the FMP are contained in the draft EIS prepared for EFH Identification and Conservation (NMFS 2004d). From these evaluations, it is understood that the crab fisheries do not effect non-benthic EFH, so the focus of this assessment will be on the EFH for benthic species. Managed species with EFH defined as benthic habitat include scallops and groundfish. The crab fisheries do not effect salmon EFH because the crab fisheries do not effect non-benthic habitat. Likewise, the crab fisheries do not effect EFH for managed species in the Gulf of Alaska (GOA) because the fisheries occur in the BSAI.

Crab is fished exclusively by pot gear in the BSAI. The extent to which pot gear impacts the benthic habitat is not well known. Although pot gear likely affects habitat during the setting and retrieval of pots, little research quantifying the impacts has been conducted to date. The EFH DEIS analyzes the pot gear for its impacts on benthic habitat. The analysis includes a description of gear and fishery operation, habitat type where the fishery occurs, and the existing measures to mitigate adverse effects of these fisheries. The analysis also looks at the total area impacted by pot gear per year and the area impacted as a portion of the total Bering Sea shelf. As shown in Table 4.4-1, the total area impacted by pot gear is less than 0.5 percent of the total area of the Bering Sea. This preliminary analysis does not indicate that the deployment or retrieval of pot gear irreparably alters the benthic environment. Through continued research, a better understanding of the effects on pot gear on the benthic habitat on a finer scale will be understood.

Most likely, the extent of impacts depends on the type of bottom habitat. The benthic species potentially impacted by pot gear are described in Section 3.3. No evidence indicates that crab fisheries that occur in the Bering Sea on mud and sandy bottom areas adversely effect the benthic habitat. Red king crabs are mostly taken in areas consisting of sandy and silty bottoms at depths of 20 to 80 fathoms (120 to 480 feet). This bottom is typically low relief, without marked features or steep slopes. Occasionally red king crab may be taken on shell hash, gravel, or cobble bottoms. They frequently feed on sand dollars, starfish, clams, scallops, and various marine worms in these areas. Norton Sound red king crabs are taken primarily in areas consisting of sandy and silty bottoms at depths of 25 fathoms or less. Blue king crabs are taken at depths of 15 to 60 fathoms (90 to 360 feet) on hard bottom, including cobble, gravel and occasional rock ledges near shore, and softer bottom off shore. Tanner crabs are taken in areas of soft sediment types (silt, mud) at depths of 30 to 110 fathoms (180 to 660 feet). Tanner crabs tend to inhabit the warmer waters of the Bering Sea where summer bottom temperatures exceed 4°C. These occur in western Bristol Bay, the Pribilof Islands, and along the shelf edge. Snow crabs are taken in areas of soft sediment types (silt, mud) at depths of 40 to 110 fathoms (240 to 660 feet). They are generally found in colder areas of the Bering Sea where summer bottom temperatures are less than 4°C. These areas occur in the mid-shelf region of the central portion of the eastern Bering Sea shelf. In areas of overlap with Tanner crab stocks, hybridization occurs.

Table 4.4-1 Total area impacted by pot gear in the Bering Sea and Aleutian Islands, per year, by fishery management plan crab fishery.

Fishery	Area of a set (ft^2)	Estimated number sets per year	Area (nm^2) Effected/year
Bristol Bay red king	49	98,694	0.1
Norton Sound red king	25	1,000	0.0
Pribilof red and blue king	49	28,381	0.0
St. Matthew blue king	49	89,500	0.1
Aleutian Islands red king	49	2,205	0.0
Aleutian Islands golden king	49	180,169	0.2
Aleutian Islands Tanner	49	7,000	0.0
Eastern Bering Sea Tanner	49	149,289	0.2
Eastern Bering Sea snow	49	170,064	0.2
Total		724,302	0.8 nm^2
Percent of Bering Sea shelf (25,000 nm^2) impacted by pot gear per year			.0003%

Notes: nm - nautical mile ft - foot
Source: Witherell In Press.

Habitat impacts may change under Alternatives 2, 3 and 4 because, with the allocation of harvester quota share, the fisheries will be spread out in time, thus subjecting EFH to impacts over a longer amount of time. On the other hand, total effort may decrease as the fishery consolidates and as fishermen reduce effort to the level necessary to catch their quota. Although, less vessels would fish, each vessel may have more pots if pot limits are relaxed. Most likely, the number of pot lifts will be directly related to the size of the quota. For example, if each pot brings up 10 legal male crab, and a fisherman's quota is 100 crab, this effort will be 10 pot lifts. And, there is a negligible difference between whether he sets 10 pots and lifts each one once or sets one pot and lifts it 10 times. With the current level of information, it is impossible to predict the extent to which spreading out the fishery will effect the habitat. At this stage it is concluded that if the fishery itself does not have significant effects on benthic habitat, then changes to the fishery as a result of rationalization will also not have a significant effect.

It is anticipated that programs of individual quotas and voluntary cooperatives will lead to reduced vessel effort and a more orderly fishery over an extended harvest period. Compared to the current fast pace, competitive derby fishery, the preferred alternative should provide these significant benefits to habitat:

- reduced effort and crowding on marginal grounds;
- temporal redistribution of effort to maximize harvest of target species and minimizes bycatch;
- reduced gear loss from fishing marginal grounds or from fishing in concentrated areas, impacting habitat by less ghost fishing of lost gear; and
- increased selectivity of gear for target and non-target species alike – multispecies retention, which in turn, reduces bycatch mortality of handled and returned crab.

Additionally, the State intends to conduct an evaluation of research on possible closed areas to protect crab spawning, settling, rearing and mating habitat, and to review the crab observer program to ascertain its value in assessing habitat impacts.

Mortality of other benthic animals during pot recoveries

Recovery of pots often involves dragging them across the seafloor, especially during storms, or if they are heavily sanded in. No studies have been conducted on the effects of this activity. On the broad sandy shelf of the eastern Bering Sea, the most likely impact is damage or mortality of other crabs in the vicinity or on the outside of the pot. Damage may also be done to other sea life including fish, snails, seastars, and bivalves. An organism of particular concern is the sea onion (*Boltenia ovifera*) which provides important habitat for young-of-the-year red king crabs (Stevens and Kittaka 1998). Sea onions are damaged and removed by on-bottom trawls (B. Stevens, NOAA Fisheries AFSC Kodiak Lab, personal observation), and probably by dragging crab pots as well. Although commercial trawling is prohibited in the area of their greatest abundance, pot fishing is most heavily concentrated there. Removals of sea onions may limit the carrying capacity of the environment for recruitment of juvenile king crabs. Fishing with pots may also create impacts by crushing, burying, or disturbing female crabs in areas of mating aggregations, according to Stevens (1994), and recent (March 2002) testimony by B. Stevens to the State BOF.

Golden king crabs are taken in areas consisting of rough, uneven bottom at depths of 100-400 fathoms (600 to 2,400 feet). Fishery effort is concentrated on rocky substrata and pinnacles in the Aleutian Islands and at the entrances to passes between the islands. Such habitats are home to many sessile animals including gorgonian corals, anemones, sea stars, crinoids, and sponges. These in turn supply shelter and food to small crabs, fish, and other organisms. Pot fishing in these areas probably has significant impacts on the hard-bottom fauna, but has not been studied. Corals and sponges are long-lived animals; once damaged or broken, they may never recover. Witherell and Coon (2000) provide a comprehensive overview of the corals off Alaska, including coral distribution and fishing effects. Coral can be damaged by the setting and retrieval of pot gear, especially longline pot gear. Little information exists on the effects of longline pot gear on coral or on the benthic habitat of the Aleutian Islands. Longline pot gear causes damage because the pots are tied together on the same groundline. These pots come on deck with rocks, coral, and other things from the sea floor. The golden king crab vessels have 100 percent observers, so data on the types and frequency of coral bycatch is being recorded. The ADF&G observer program has begun to collect and build a database on the locations and species of coral brought on deck in the Aleutian Islands golden king crab fishery. Since this fishery is not yet a derby-style fishery, most likely, under the rationalization program alternatives, prosecution of the fishery would not change greatly. Continued observer data collection focusing on recording where and which types of coral are brought up in the fishery would improve our understanding of this issue. The potential effects of the golden king crab fishery on EFH will be further analyzed in the EFH DEIS currently being prepared.

Ghost fishing

Ghost fishing by derelict pots is another environmental concern to EFH. Lost by the fishery, these pots may continue to entrap crab and fish until their netting or escape panels disintegrate (Stevens et al. 2000). Ghost fishing has resulted in management measures that limit the number of pots a fisherman can use and require that each pot be equipped with a degradable panel. Since 1996, ADF&G has required pots to have a panel of degradable mesh to reduce ghost fishing. Degradable panels decrease the ability of a lost pot to ghost fish in the long term because once a panel degrades, the pot can no longer capture crab or other benthic species. As ghost pots are unbaited, the primary attraction of derelict pots is their physical structure, which adds complexity and vertical relief to the generally featureless environment in the Bering Sea. Lost pots cause other problems besides ghost fishing. Since pots are hard structures, they can damage the gear used by other fisheries, such as bottom trawl gear.

Slowing the pace of fisheries under rationalization program alternatives could also potentially reduce gear loss and prevent the conservation concerns associated with ghost fishing. For the crab fisheries, ghost fishing is probably more of a problem in a derby fishery than in a rationalized fishery. Pots are expensive, and most likely, a fisherman would avoid losing pots. In the race for fish, the risk of losing a pot was balanced against the advantage of harvesting more crab. With an allocation of quota, there is less of an incentive to risk losing pots because the harvest amount is guaranteed. However, to prevent fishermen from deploying an unlimited amount of pots, some pot limits may be required to prevent pot loss from ice movement or gear conflicts. If too many pots are deployed at the ice edge, when the ice moves forward, some pots are lost because the vessel that deployed them cannot pick up all the pots before they are covered with ice.

Mortality of organisms in lost pots

Crabs and other organisms are attracted to derelict fishing pots even after all bait has decomposed. While some crabs escape, others die due to starvation. Dead crabs and fish act as bait to attract other animals, creating a self-baiting cycle. Estimates of pot loss rates are unreliable, but may have been as high as 20,000 pots per year in the late 1980's (Alaska BOF as cited in Paul et al. 1994); even 10 percent loss per year would contribute 5,000-10,000 lost pots each year. Using sidescan sonar, Stevens et al. (2000) estimated the number of ghost pots in a 4.5 km^2 area of Chiniak Bay, near Kodiak, to be 42 pots km^2. Extrapolation to a 40,000 km^2 area of the Bering Sea (where fishing for king, Tanner, and snow crab is particularly intensive) would yield 1.68 million pots in various stages of degradation. Stevens (1996) estimated pot numbers in the Bering Sea using an exponential decay function; assuming a half-life of 4 years, and 7,000 pots lost annually, the number of active pots would stabilize at 44,000 after 40 years. The actual number is probably somewhere between these extremes.

Other benthic organisms found in lost pots in Kodiak (Stevens et al. 2000) included Sunflower stars (*Pycnopodia helianthoides*) (42 percent occurrence), hairy tritons (*Fusitriton oregonensis*) (15 percent occurrence), and white anemones (*Metridium senile*) (3 percent occurrence). Octopus (*Octopus dofleini*) occurred in all pots with >10 crabs and are a significant source of crab mortality. In the Bering Sea, various species of Neptunea, the sea star (*Asterias amurensis*) are common occupants of recovered crab pots, but numbers are not known (B. Stevens, NOAA Fisheries Kodiak Lab, personal observation).

Ecosystem effects

Changing the times and locations where the fishery is concentrated could have effects on the ecosystem, but these would be difficult to predict, especially without knowing where the fishermen will go when fishing seasons are expanded. Changes in the spatial distribution of the crab fishery could alleviate fishing impacts on discrete populations of crab. However, it is possible that bycatch of some other species may increase in other areas. If the fleet is required to move elsewhere in search of high concentrations of crab, bycatch of other species could be affected in either direction. Actions that significantly reduce the availability and population of a major prey species, through direct harm, capture, or adverse impacts to the prey species' habitat, may be considered to have adverse effects on a managed species and its EFH. The rationalization program alternatives, since they would change fishing patterns, could change the proportions of species caught in the directed fishery and as bycatch. It is possible that some adverse impacts to prey for managed species could occur in some areas. However, it is not probable because the crab fishery does not catch measurable amounts of crab prey species as bycatch. A more complete description of the effects of the alternatives on the BSAI ecosystem is included in Section 4.5.

An effect on species fecundity might be expected if food intake to support reproduction were affected. The preferred alternative does not however appear to be likely to adversely affect the abundance and availability of prey for crab. Although this cannot be stated with certainty, it is not expected that any of the alternatives would have an adverse impact on growth, reproduction or fecundity.

Cumulative effects on essential fish habitat

Because none of the alternatives will affect the size of the TAC for each crab fisheries and because the BSAI crab fishery is conducted exclusively with pot gear which is relatively clean, that is, since direct and indirect effects on EFH for crab are expected to be relatively minor, specific cumulative effects of this action taken together with other fishery actions would be difficult to identify. The EFH DEIS (NMFS 2004d) contains a section dealing with the cumulative effects of fishing on EFH. Crab are impacted by bottom trawl gear, which compound the cumulative effects of crab fishing. To mitigate the effects of trawl gear on crab EFH, the Council has established closed areas and prohibited species caps to limit the amount of crab caught as bycatch, which also limits the amount of bottom trawling in crab habitat. The Alaska Groundfish Fisheries Final Programmatic Supplemental EIS contains a complete discussion of the effects of the bottom trawl fisheries on crab EFH (NMFS 2004a).

The temporal changes to fishing patterns described in Section 4.1 would have no direct effect on EFH, but a more even distribution of the catch throughout the year might reduce the likelihood of indirect adverse ecosystem effects to EFH by minimizing the potential for temporary localized depletion. The action is not expected to have an adverse impact on growth, reproduction or fecundity.

Few direct effects are expected as a result of the changes in spatial distribution. For managed species which are associated with the bottom, there could be some effects (both positive and negative) from redistribution of pot gear effort. Effort in some areas would be lowered, and in others could be increased. Fishing effort will continue to occur in areas with high abundance of large male crabs. In the context of the fishery as a whole and of the other fisheries in the North Pacific, any direct effects from redistribution of pot gear effort on the substrate and water column, beneficial or adverse, are expected to be relatively minor.

The redistribution of effort could affect the levels of other species taken as bycatch in the crab fisheries. Again, levels would be raised or lowered in different areas as areas of fishing concentration changed. Changes in bycatch levels could have EFH implications for managed species in that predator-prey relationships could be affected. However, bycatch rates of species other than crab in the crab fisheries is extremely low, and any impact on bycatch rates from Alternatives 2, 3 and 4 should be inconsequential.

4.4.3 NOAA Fisheries conclusions regarding the effects of the actions on essential fish habitat

NOAA Fisheries concludes that all alternatives under consideration may have adverse impacts on EFH for managed species under the four FMPs, but that the potential adverse impact on EFH is not substantial. That means that adverse effects may be occurring but that they do not rise to the level requiring minimization, that level being established by the EFH final rule as adverse effects that are more that minimal and not temporary in nature. This conclusion is based on the analysis presented above and the existing mitigation measures in place the BSAI crab fisheries. Pot gear, and the action of setting and retrieving pots, does effect EFH, as discussed above. Fish, crab, and other benthic species are captured and removed from the ecosystem, some discarded animals die, and an indeterminable number of benthic species die from ghost fishing. Pot gear damages or captures other benthic species and may cause habitat degradation. However, based on the information available, NOAA Fisheries - Sustainable Fisheries determined that these effects do not result in substantial adverse effects on EFH. NOAA Fisheries - Habitat Conservation concurred with this determination (NMFS 2004e).

4.4.4 Essential fish habitat mitigation

Extensive measures to mitigate the effects of the crab fisheries on EFH have been implemented under status quo management.

- **Gear.** Pots are the only legal gear type. Pots require biodegradable panels, to minimize ghost fishing by lost or derelict gear. Also the FMP prohibits crab harvesting with tangle nets, which are very destructive to benthic habitat. Pots require escape rings and/or large mesh panels designed to permit the escape of non-target crabs. The number of pots a vessel can fish is limited by regulation to reduce accidental loss of gear, to produce efficiency controls on the fisheries, and to slow down the fishery for better management.

- **Harvest strategies.** Harvest limits for most fisheries are set according to formulas that incorporate bycatch and handling mortalities into calculation of the harvest amount.

- **Fishing seasons.** The opening date and mandatory closure dates are established to avoid mating and molting periods. The season length is usually determined by quota because fisheries are closed when the quota is reached. Recently, this has occurred after fewer than 10 days of fishing. This has produced near year-round closure of these grounds to the directed fishery.

- **Limited access.** Beginning in 2000, the LLP has provided for a limit on the maximum number of vessels allowed in the fishery. The Norton Sound fishery is managed as a super-exclusive area. Vessels that fish in this fishery may fish in no other king crab fishery in the state. This provision protects this extremely small stock from excess fishing effort.

- **Size and sex restrictions.** A prohibition on the retention of female crabs is designed to maximize overall reproductive potential. Male size limits are set to ensure that males have at least one mating season before becoming vulnerable to the fishery. The legal size for mature males are established for each fishery. In addition, the exploitation rate is set conservatively to assure that there are adequate males of various size classes available to meet reproductive needs.

- **Area closures.** Areas are closed to protect the subsistence fishery. There is a near shore area closed to all fishing around St. Matthew Island to protect spawning stocks and crab habitat.

The rationalization program alternatives would not change any of these mitigation measures, except limited access. The rationalization program alternatives do not include any specific measures to mitigate the effects on EFH, however, many of the resulting changes to the prosecution of the fishery would potentially reduce impacts of the fisheries on EFH. The rationalization program alternatives would reduce the number of vessels that participate in the crab fisheries, which would further reduce any effects of the fishery on EFH. The rationalization program alternatives would also potentially reduce the effects of the fisheries on EFH by providing fishermen the time to improve fishing practices, i.e.: longer soak times, less gear waste. With a guaranteed share of the harvest, fishermen would have the time to be selective and chose where to fish to avoid fishing on grounds with undersized and female crabs. Indirectly, the rationalization of the BSAI crab fisheries under may lessen the fishing effort in certain areas and the potential impact to EFH in those areas. On the other hand, the effort thus displaced could increase impacts in other areas which are currently less heavily fished. However, the effect of these actions on EFH are expected to be negligible. Increases in monitoring and observer coverage from implementing any of the rationalization program alternatives would increase our understanding of the impacts of these fisheries on EFH by providing better bycatch information and fishery locations. NOAA Fisheries does not see a need for additional mitigation for EFH in connection with the proposed alternatives.

4.5 Predicted effects of the alternatives on the BSAI ecosystem

In Section 4.5, the alternatives are analyzed with respect to various ecosystem-level measures that might indicate the impacts of the alternatives from a broader ecological viewpoint. Section 3.1 contains a discussion of the BSAI ecosystem and the ecosystem components that interact with the different life stages of crab.

Table 4.5.1 Significance table for ecosystem. Criteria for determining the significance of direct and indirect effects of the BSAI king/Tanner crab fisheries on the BSAI ecosystem: significant adverse (S-), insignificant (I), or unknown (U).

Effects	Score		
	S-	I	U
1. Predator/prey relationships	Fishery induced alterations to predator-prey relationships.	No detectable fishery induced alterations to predator-prey relationships.	Insufficient information available on alterations to the predator-prey relationships.
2. Energy flow and balance	Long-term changes in system biomass, respiration, production or energy cycling due to fishery removals, fishery discarding, and offal production practices.	No detectable fishery induced long-term changes in system biomass, respiration, production or energy cycling.	Insufficient information available on fisheries interactions with long-term changes in system biomass, respiration, production or energy cycling.
3. Biological diversity	Catch removals high enough to cause changes to species diversity, trophic diversity, and/or genetic diversity.	Catch removals do not cause changes to species diversity, and/or genetic diversity.	Insufficient information on fishing alterations to species diversity, trophic diversity, and/or genetic diversity.

Table 4.5.-2 Summary table of effects of each alternative on the BSAI ecosystem.

Effect	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Predator/prey relationships	I	I	I	I
Energy flow and balance	I	I	I	I
Biological diversity	I	I	I	I

Effects on predator-prey relationships

Fisheries can remove predators, prey, or competitors and thus alter predator-prey relationships relative to an unfished system. Studies from other ecosystems have been conducted to determine whether predators were controlling prey populations and whether fishing down predators produced a corresponding increase in prey.

Similarly, the examination of fishing effects on prey populations has been conducted to evaluate impacts on predators. Finally, fishing down of competitors has the potential to produce species replacements in trophic guilds (Hall 1999). Evidence from other ecosystems presents mixed results about the possible importance of fishing in causing population changes of the fished species' prey, predators, or competitors. Some studies showed a relationship, while others showed that the changes were more likely due to direct environmental influences on the prey, predator, or competitor species rather than a food web effect. Fishing does have the potential to impact food webs but each ecosystem must be examined to determine how important it is for that ecosystem. A review of fishing impacts to marine ecosystems and food webs of the north Pacific under the current fisheries management system was provided in the Alaska Groundfish Fisheries Draft Programmatic Supplemental EIS (NMFS 2003b).

Fishing can selectively remove fish eating predators then move down the food web and begin removing the next trophic level down such as plankton feeding fish. This process is known as fishing down the food web (Pauly et al. 1998). Trophic level of the fish and invertebrate catch from the BSAI and GOA was estimated from the 1960's to present (Livingston et al. 1999; Queirolo et al. 1995) to determine whether such fishing down effects were occurring. Trophic level of the catch in all three areas has been relatively high and stable over the last 30 or more years.

Fishing vessels and vessels supporting fishing operations have the potential to disrupt predator-prey relationships through the introduction of nonindigenous species. These introductions occur when ship ballast water containing live organisms is obtained outside a region and is released into fishery management areas. Vessels also have organisms fouling their hulls that can be transported between regions. These organisms have the potential to cause large alterations in species composition and dominance in ecosystems (Carlton 1996).

Fishing patterns under the alternatives are expected to differ primarily with respect to temporal dispersion of effort and secondarily with respect to spatial distribution of effort (Section 4.1). The effects of removal of crab species on predator-prey relationships has not been a concern in the status quo regime because of the small amount of crab biomass removed from the system and the fact that crab are not prey for marine mammals and seabirds. Additionally, it is expected that the rationalization program alternatives would result in decreased temporal/spatial concentration of the BSAI crab fisheries and may decrease any effects of the fisheries on predator prey relationships. For these reasons, the effects of the alternatives on predator-prey relationships are determined to be insignificant.

Effects on energy flow and balance

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. A mass-balance model of the eastern Bering Sea (Trites et al. 1999) provides some information on fishing removals relative to total system production and the distribution of biomass and energy flow throughout the system in recent times. The trophic pyramids (distribution of biomass at various trophic levels) indicate that biomass and energy flow are distributed fairly well throughout the system (Trites et al. 1999). These show that the Bering Sea is a more mature system compared to other shelf systems. A more mature system is one that is less disturbed (Odum 1985). Total catch biomass (including non-groundfish removals) as a percentage of total system biomass (excluding dead organic material, known as detritus) was estimated to be 1 percent, a small proportion of total system biomass. Fishery removal rates are based in the most basic sense on the amount of surplus production (the excess of reproduction and growth over natural mortality) (Hilborn and Walters 1992) for fish stocks. Because there is great variability among stocks with regard to the amount of this excess production, it is likely more important that removals stay within the bounds of each individual stock's excess production (a topic that is considered in the individual stock impacts sections). From an ecosystem point of view, total fishing removals are a small proportion of the total system energy budget and are small relative to internal sources of interannual variability in production.

Fisheries can redirect energy in the system by discarding and returning fish processing wastes to the system. These practices take energy and potentially provide them to different parts of the ecosystem relative to the natural state. For example, discards of dead flatfish or small benthic invertebrates might be consumed at the surface by scavenging birds, which would normally not have access to those energy sources. The total offal and discard production as a percentage of the unused detritus already going to the bottom has not been estimated for crab. Crab discards are either at sea, which a large portion of the discarded crab are presumed to live, and discharged processing waste. The processing waste and the effects of the environment are discussed in Section 3.3.6 and Section 4.3.5. The annual consumptive capacity of scavenging birds, groundfish, and crab in the eastern Bering Sea was determined to be over ten times larger than the total amount of all offal and discards produced in the BSAI and GOA.

Discards and offal production can cause local enrichment and change in species composition if discards or offal returns are concentrated. Some evidence of those effects have previously been cited (Thomas 1994) in areas with inadequate tidal flushing (Orcas Inlet in Prince William Sound and in Dutch Harbor) but not in the deep water disposal site in Chiniak Bay off Kodiak Island (Stevens and Haaga 1994). Local ocean properties (water flow and depth) and amount of water discharged per year could be important factors determining the effect of nearshore disposal on local marine habitat and communities. Changes to the processing plant at Dutch Harbor dramatically reduced the amount of offal and ground discards discharged.

A mass-balance model of the eastern Bering Sea (Trites et al. 1999) showed that total catch biomass (including groundfish removals) as a percentage of total system biomass (excluding dead organic material, known as detritus) was estimated to be 1 percent, a small proportion of total Bering Sea system biomass. From an ecosystem point of view, total fishing removals are a small proportion of the total system energy budget and are small relative to internal sources of interannual variability in production. Thus, total removals, which are unchanged under all of the alternatives, would have an insignificant effect on the environment.

Combined evidence regarding the level of discards relative to natural sources of detritus and no evidence of changes in scavenger populations that are related to discard trends suggest that all of the alternatives would have insignificant ecosystem impacts through energy removal and redirection. Under the alternative rationalization programs, discards are predicted to decrease as fishing practices change. The extent of this decrease cannot be predicted with accuracy because the exact changes to fishing practices cannot be predicted with any certainty. Likewise, offal production may decrease as processing practice improve recovery rates. This decrease is likely to be minimal, and the effects of this decrease would not be measurable.

Effects on biological diversity

Fishing can alter different measures of diversity. Species level diversity, or the number of species, can be altered if fishing removes a species from the system. Fishing can alter functional or trophic diversity if it selectively removes a trophic guild member and changes the way biomass is distributed within a trophic guild. Fishing can alter genetic level diversity by selectively removing faster growing fish or removing spawning aggregations that might have different genetic characteristics than other spawning aggregations. Large, old 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), thus one would expect a decline in genetic diversity due to heavy exploitation.

The scientific literature on diversity is somewhat mixed about what changes might be expected due to a stressor. Odum (1985) asserts that species diversity (number of species) would decrease and dominance (the degree to which a particular species dominated in terms of numbers or biomass in the system) would increase if original diversity was high, while the reverse might occur if original diversity was low. Genetic diversity can also be altered by humans through selective fishing (removal of faster growing individuals or certain spawning aggregations). Accidental releases of cultured fish and ocean ranching tends to reduce genetic diversity (Boehlert 1996). More recently, there is growing agreement that functional (trophic) diversity might be the key attribute that lends ecosystem stability (Hanski 1997). This type of diversity ensures there are sufficient number of species that perform the same function so that if one species declines for any reason (human or climate-induced), then other species can maintain that particular ecosystem function and less variability would occur in ecosystem processes. However, measures of diversity are subject to bias and how much change in diversity is acceptable is not really known (Murawski 2000).

Localized extinctions due to fishing are rare but some evidence exists that this may have occurred to some skate species in areas of the North Atlantic (Greenstreet and Rogers 2000). These extinctions could be thought of as a decrease in species level diversity or the actual number of species in an area. Elasmobranchs such as shark, skate, and ray species may be vulnerable to fishing removals and direct impacts. No fishing induced extinctions have been documented for any fish species in Alaska during the last 30 years or so. Taxonomic work on some fish species (e.g., skates) is ongoing and minimal survey and systematic work is being done on other ecosystem components, such as benthic invertebrates, that could be impacted by fishing activities.

Diversity may not be a sensitive indicator of fishing effects (Jennings and Reynolds 2000; Livingston et al. 1999). Studies of other more heavily fished systems, such as the North Sea, Georges Bank, or Gulf of Thailand have shown declines in diversity (Hall 1999; Jennings and Reynolds 2000) related to fishing, and the diversity declines were due to direct mortality of target species.

Evidence so far in highly fished areas such as the North Sea suggests that there is little evidence of genetically induced change in selection for body length in cod after 40 years of exploitation (Jennings and Kaiser 1998). Genetic diversity has not been assessed under Alternative 1, but heavy exploitation of certain spawning aggregations can be inferred and heavier exploitation on older, more heterozygous individuals would have the tendency to reduce genetic diversity in fished versus unfished systems. Thus, some change in genetic diversity has possibly occurred in the BSAI, but the magnitude of the impacts are not known. The North Sea work indicates the impacts might be minimal (Rice and Gislason 1996). Genetic assessment of crab populations and subpopulations in the North Pacific shows some genetic differences among stocks but has not demonstrated any genetic variability across time within stocks that might indicate fishing influences.

No fishing induced extinctions of crab or other marine species have been documented in the last 30 years or so. However, king crab populations in near Kodiak have crashed and not returned to past levels of abundance despite eliminating fishing. No fishing-induced changes in functional (trophic) diversity under the current management regime have been detected (NMFS 2001a). Thus, functional diversity was considered to be an insignificant effect on the environment. There is a concern that because crab fisheries only remove the largest males, that the fisheries may alter the genetic diversity of the stock. Research is ongoing on this subject, however, given the information available to date, this concern is hypothetical. Genetic diversity changes due to removal of larger crab that have not been quantitatively assessed, but because research on more heavily fished areas indicates impacts are minimal all of the alternatives were judged to have a insignificant impact on biological diversity.

4.6 Economic and socio-economic effects of the alternatives

This section assesses several different economic effects of the alternatives. Some of the economic impacts of the different alternatives are very similar. In those instances, the discussion of one alternative may make reference to the description of impacts for another alternative to avoid repetition. Any pertinent distinctions between the impacts of the different alternatives are noted.

The section includes analysis of the effects of the alternatives on efficiency in harvesting, efficiency in processing, capacity in the harvest sector, capacity in the processing sector, the distribution of benefits from the fisheries between the harvesting and processing sectors, entry to the harvest sector, entry to the processing sector, captains and crews, benefits to consumers, and benefits to the environment.

In general, the economic effects of the different alternatives cannot be quantified. Quantitative estimation of the effects on harvesters and processors requires accurate data concerning several aspects of the fishery, many of which are not available. In addition, several factors limit the predictability of the impacts of the alternatives on these fisheries. Several program aspects of the alternatives are unique. For example, the "three-pie voluntary cooperative" alternative differs from any implemented in any fisheries to date. Quantification of impacts would require detailed cost information from both the harvesting and processing sectors and thorough economic analysis of those data. No such information is currently available. Lastly, crab stocks are highly volatile and unpredictable. The impacts of the alternatives could be affected by any fluctuations in crab stocks further limiting the extent to which those effects can be quantified.

The foundations for this analysis are contained in the RIR/IRFA that is attached as Appendix 1. Please consult that document for additional information.

Economic and socioeconomic significance methodology

The analysis of economic and socioeconomic impacts of the alternatives is largely qualitative. As a result, the ability of analysts to determine whether certain impacts of alternatives exceed thresholds is imprecise. In addition, several of the conclusions are uncertain and may depend on the responses of several persons to the incentives created by an alternative. Since quantitative estimates of impacts are not available, the analysis in the text is relied on to justify the significance conclusions. The analysis will provide readers with a more complete understanding of the implications of the alternatives than the significance conclusions. Current levels of the appropriate factor or issue are the reference points for evaluating the alternatives. The significance conclusions rely on the following definitions:

Score	Effect
I	Insignificant (no impact or a marginal impact)
S-	Significant adverse (a substantial negative impact)
S+	Significant positive (a substantial positive impact)
U	Unknown (unknown or uncertain impact)

The analysis and the consequent significance conclusions are limited by several factors. First, several program aspects are novel, having never been implemented in any fishery. For example, the issuance of processor shares, the regional and community protections, and the arbitration program in the "three-pie voluntary cooperative" alternative are not in place in any fishery. Second, the circumstances in the North Pacific crab fisheries differ from those of fisheries elsewhere and other fisheries in the North Pacific. For example, crab must be processed live, complicating the development of fresh markets such as those that have prospered for halibut since the issuance of IFQ in that fishery. The circumstances in the crab fisheries limit the ability of analysts to predict the impacts of similar management measures with certainty. Third, data concerning the economics of the fishery are very limited. Quantification of impacts would require detailed cost information from both the harvesting and processing sectors and thorough economic analysis of that data, which could take considerable time to complete. No such information is currently available. Lastly, crab stocks are highly volatile and unpredictable. The unpredictability of crab stocks makes any projection of effects very difficult. As a result of these complications, the significance conclusions reached by the analysts for some factors are tentative and depend on the specific circumstances in the fisheries. The uncertainty in conclusions is reflected by the "unknown" finding, with the tentative significance finding in parentheses. The "unknown" significance conclusions mean only that based on the best available science, a precise significance finding cannot be determined at the significance threshold level. The variation in the different rationalization alternatives and their protections may also result in differences in the effects during transitions (such as at implementation and when stocks sizes fluctuate greatly). These differences are discussed in the text. A more complete description of the differences between the alternatives is provided in this section, which should provide the reader with an understanding of the differences in the alternatives and the factors that are likely to lead to differences in the effects of the alternatives.

Social and community impacts vary by alternative and between communities under any particular alternative. In general, the fewest community impacts result from the three pie alternative, due to both regionalization and community protection features. In terms of community or social impacts, the IFQ alternative is intermediate between the other two rationalization alternatives due to the presence of the regionalization feature and the absence of community protection features. The cooperative alternative has neither regionalization nor community protection features. Absent community protection and/or regionalization features, a number of communities engaged in or dependent upon the crab fishery would likely no longer participate in the fishery as a result of various forms of consolidation facilitated under rationalization conditions. Impacts will vary in nature between communities based on the local presence of processing activity, local fleet activity, and the presence of support service businesses, along with relative degree of fisheries dependency, among other factors. Information on impacts to specific communities may be found in Section 4.6.5 and in the detailed community profiles in the social impact assessment in Appendix 3.

Significance Conclusions

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Entry to the harvest sector	I	U	U	U
Entry to the processing sector	I	U	U	U
Harvest capacity	I	S+	S+	S+
Processing capacity	I	S+	S+	S+
Harvester efficiency	I	U (I/S+)	S+	U (I/S+)
Processor efficiency	I	U (I/S+)	U (S-/I/S+)	U (I/S+)
Overall production efficiency	I	S+	S+	S+
Excessive Shares	I	I	I	I
Spillover effect on other fisheries	I	I	I	I
Captains and crew	I	U	U	U
Consumer benefits	I	S+	S+	S+
Environmental benefits	I	S+	S+	S+
Community/social impact - harvesters	I	U	U	U
Community/social impact - processors	U	U	U	U
Community/social impact - employment and Income	U	U	U	U
Economic support services	U	U	U	U
Municipal revenue	U	U	U	U
CDQ participation and benefits	I	U	U	U

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Environmental justice - employment effects	I	U	U	U
Environmental justice - communities impacts	I	U	U	U

4.6.1 Entry and capacity

4.6.1.1 Entry to the harvesting sector

An important component of the economics of the fisheries is the entry to the harvest sector. This section examines opportunities for entry under the different alternatives under consideration.

Effects of the status quo alternative on entry to the harvest sector

Under the current LLP management, entry to the crab fisheries is costly. Entry into these fishery requires the purchase of an LLP permit and a properly configured vessel from which to fish. Permit prices are not publicly available and vary in cost depending on the endorsements attached to the license and the history associated with the license, which could be rewarded with a harvest allocation under a future share-based program. Entry into the Aleutian Islands golden king crab fishery is even more expensive as vessels require additional gear[1] unique to those fisheries.

The number of endorsed licenses that are currently not being fished suggest that the crab fisheries are currently fully capitalized and entry is unlikely in the near future. If stocks recover, entry could likely occur through license holders reintroducing vessels to the fisheries or through the transfer of licenses to new entrants. In the past, entry into the fishery has occurred in a few different ways. Crew members have worked their way up to become skippers and used the substantial crew shares these fisheries are known for to purchase interests in vessels. Alternatively, persons have entered the fishery as an investment. These persons typically use capital from other sources to purchase vessel interests in the fishery. In the long run, the substantial costs of entry would likely to continue, if the current management is maintained. Entry is likely to be deterred by both these costs and the risks associated with fisheries that experience substantial unpredictable stock changes.

Effects of the three-pie voluntary cooperative alternative on entry to the harvest sector

The effects of the three-pie voluntary cooperative on entry to the harvest sector are difficult to predict. Entry could occur through the purchase of quota shares without ownership of a vessel. IFQs could then be fished from a vessel on which the quota share owner crews or by leasing the IFQs to a vessel owner. This would allow a gradual entry to the fishery by both crews or investors. The cost of entry is determined in part by quota share prices, which will depend on the distribution of benefits between the sectors. These benefits, in

[1] This is primarily gear specific to longlining pots. Pots are set and retrieved individually in other crab fisheries.

turn, depend on the ex-vessel price effects of the arbitration program and the dynamics of the Class A share-Class B share ratio. While these affects cannot be predicted with any certainty, a few general observations about the effects of the alternative on entry can be made. The larger the share of the intrinsic value of the crab resource captured by harvests (and therefore embodied in the harvest share price), the more costly entry to the harvest sector will be. So, if most of the intrinsic value of crab is realized by holders of harvest shares, new entrants will have to pay a greater amount for those shares. In addition, if those shares carry a substantial portion of the intrinsic value of the resource, it is possible that recipients of an initial allocation will be reluctant to sell their quota shares, but will instead choose to lease shares to take advantage of the stream of income arising from the resource interest embodied in the shares. If little of the resource value is carried by the harvest shares, those shares will sell for a lower value and could be more available on the market, since the share will primarily represent the opportunity to earn normal profits from engaging in harvesting in the fishery. As noted, this effect cannot be predicted with any certainty.

The cooperative structure of this alternative could be an obstacle to entry, if cooperative members rely on those relationships for selling shares to other cooperative members. In addition, the use of cooperatives for harvesting of shares could lead to greater leasing, which could inhibit the development of a market for harvest shares. The development of a market for harvest shares is critical to entry. The extent of the market, however, cannot be predicted.

Entry under this alternative could be aided by the 3 percent C share allocation, which in general are required to fished by the holder of those shares. These shares can be expected to sell for a discounted price because of the limitations on their use. Yet, since these shares make up only 3 percent of the total harvest share allocation, the extent to which crew could purchase a significant interest in the fisheries through C share purchases alone is limited. The low interest loan program proposed to aid crew in the purchase of shares is also likely to facilitate entry to the fishery and could alleviate financing difficulties or dependence on vessel owners through loans to crew for share purchases. The willingness of private markets to finance share purchases could be limited since volatility of crab stocks could make shares a risky asset.

Effects of the IFQ alternative on entry to the harvest sector

Entry to the harvest sector under the IFQ alternative will require the purchase of harvest shares. Small-scale entry under this alternative could be easier than under the status quo. The relative ease of entry arises because a harvester can invest in the fishery incrementally. For example, entry could occur through the purchase of a few IFQ without purchase of either a long term quota share investment or ownership of a vessel. The division of the fishery by severable share allocations allows this gradual entry to the fishery by both crews or investors. The cost of entry is determined in part by share prices, which will depend on the distribution of benefits between the sectors. Since harvest share recipients are likely to realize a substantial portion of the intrinsic value of the resource under a harvester-only IFQ program, harvest shares are likely to be relatively expensive in comparison to the other two rationalization alternatives. In addition, the market for quota shares, the long term interests in the fishery, could be limited if owners perceive these shares as a reasonable means to maintain a stream of income. Quota share owners with this mind set could elect to lease those shares annually, rather than sell the long term interest to entrants.

Processors could also purchase interests in the harvest sector, if they perceive an advantage to vertically integration. Vertical integration could assist a processor in overcoming some of the costs associated with coordinating deliveries from harvest vessels that could arise in a harvester-only IFQ program. Processors will be more likely to purchase shares for this purpose under the IFQ program than under the three-pie voluntary cooperative alternative since processors will lack the leverage of processing shares under the IFQ alternative. The processor purchase of harvest shares could further limit entry opportunities for independent harvesters.

As under the three-pie voluntary cooperative alternative, the C share program and the crew loan program could facilitate some entry to the fisheries. Whether captains and crew can use these shares and loans to develop a long term interest in the general harvest sector cannot be predicted.

Effects of the cooperative alternative on entry to the harvest sector

As under the other two rationalization alternatives, entry to the harvest sector under the cooperative alternative is difficult to predict. Entry under this alternative would be limited to the purchase of long term interest of catch history under which the privilege to receive an annual allocation arises. Entry opportunities could be limited slightly under this alternative since annual allocations are made to cooperatives, limiting the ability of harvesters to enter the fishery through a lease. Entry through leasing under any alternative is likely to be very limited since leasing does not carry a long term interest that can be relied upon. As under the other rationalization alternatives, the cost of entry is determined in part by the price of shares, which will depend on the distribution of benefits between the sectors. The affects of the cooperative structure's processor protections (particularly the obligation to deliver harvests to the associated processor and the mechanism for moving between cooperatives) will determine the distribution of benefits between the sectors. In general, the degree of processor protection provided by these provisions is less than the protection of processor shares under the three-pie voluntary cooperative alternative and greater than the processor protection of the IFQ program, which provides no direct processor protection. Consequently, the price of catch history under this alternative is likely to be greater than the price of equivalent harvest shares under the three-pie voluntary cooperative alternative and less than the equivalent harvest share price under the IFQ alternative.

The mandatory cooperative structure of this alternative could limit entry to some extent, if cooperative associations affect the trading of shares. For example, a cooperative member might be more likely to sell to another cooperative member (or even the associated processor) than to a new entrant to the fishery. If these cooperative members trade most commonly with other cooperative members, the market for the trading of catch histories may not develop in a manner that facilitates entry.

As under the other rationalization alternatives, small scale entry could be facilitated by the C share program. The owner on board requirement should lead to C shares selling for a discounted price, which together with the loan program for crew members, should aid persons who want to make a transition from crew member to owner in the fishery. The C share program also could help to overcome obstacles to entry arising from the cooperative structure. If C share holders are members of cooperatives it is possible that other holders of catch history may be willing to work with C share holders to facilitate their development of a larger interest in the fisheries. The extent of this effect, however, cannot be predicted.

4.6.1.2 Entry to the processing sector

Effects of the status quo alternative on entry to the processing sector

Under the current management, processor entry is not limited by any direct regulation (Table 4.6-7). Entry, however, is limited by operational difficulties arising from the remoteness of the fisheries and the prosecution of the fisheries that has resulted from the race for fish under LLP management. In recent seasons in the largest fisheries, processing has occurred over the course of a few weeks. Although seasons in the fisheries in the Aleutian Islands are longer, those fisheries support fewer facilities since total harvests are significantly less than larger fisheries. Since most crab processing is concentrated in a short period of time, entry to the fishery is complicated by the need to support the required capital investment with activities from other fisheries. A crab processing facility that operates in other fisheries would be much more likely to succeed than a facility that supports only crab processing. Since the processing sector of most other North Pacific fisheries is fully capitalized, opportunities for entry are greatest for current participants in those fisheries who are able to convert existing processing facilities for use in crab. The low total harvest levels in the major fisheries currently limits these opportunities. Recovery of stocks and increased total harvests would increase opportunities for entry.

Effects of the individual fishing quota alternative on entry to the processing sector

A harvester only IFQ program would allow free entry of processors willing to pay the market ex-vessel price for crab that arises under that program (Table 4.6-7). The end of the race for fish under this alternative will clearly be a factor in processor entry. Although entry to the market would be unlimited by regulation, market and the operational requirements for participation are likely to complicate entry to the processing sector. As under the current management, entry to the processing sector will require a processor to develop markets for products and cope with operational difficulties in these remote fisheries. Existing processors will have a clear advantage over newcomers because of experience and existing infrastructure and capital. Product developments that could be facilitated by the removal of time pressures on processing arising under the current race for fish could provide opportunity for entry of new processors that are willing to pursue those innovations. In addition, the potential to serve fresh markets for a longer period of time could provide opportunity for entry of processors willing to develop new markets. The extent of these opportunities cannot be predicted. New entry also could come from harvesters that use the opportunity created by the end of the race for fish and the harvester control of harvests and landings of a harvester-only IFQ program to vertically integrate. The potential for harvesters to pursue this opportunity to vertically integrate cannot be predicted.

In the long run, absence of regulatory limits on entry could facilitate some small-scale entry. Some of these entrants could develop into large-scale participants, over time. The high risk associated with the entry to fish processing in the crab fisheries, arising in part because of the fluctuation in stocks together with the uncertainty concerning market share under this alternative, could discourage some entry to the fisheries. As under the status quo alternative, the most likely entrants are existing processors that can expand their operations into the crab fisheries, particularly in seasons of high TACs. Prediction of entry opportunities in the long run are very difficult because of uncertainties in the fisheries and in the consequences of this management alternative.

Effects of the three-pie voluntary cooperative alternative on entry to the processing sector

As under all of the alternatives, entry to the processing sector will be complicated by the challenging operational requirements and need for market development of these fisheries. Entry to the processing sector will also be affected by the structure of the three-pie voluntary cooperative alternative (Table 4.6-7). The ability of processors to enter the fishery will be determined in large part by the ex-vessel price of crab, the first wholesale market for crab, and the resulting market price of processing shares. Under a two-pie IFQ program, with 90 percent of each fishery allocated through processing shares, long-term entry to the processing sector will occur most commonly through the purchase of processing shares. Processing shares in this program would create a regulatory barrier to entry. The extent of the barrier depends on the market price of processing shares, which cannot be predicted. The relatively few number of processors in the crab fisheries could lead to a limited market for processing shares, which would complicate entry to the processing sector.

The allocation of a minimum 10 percent of the harvest quota as Class B shares, which can be delivered to any processor, could facilitate some entry to the processing sector. Processors that serve small, niche markets that have minimal capital investments would be most likely to enter through the purchase of crab harvested with these shares that have no processor share landing requirements. In years of high total harvests, some processors could enter with the more traditional processing operations by purchasing crab harvested with Class B shares or crab harvested with Class A shares that exceed the cap on processing shares in the Bristol Bay red king crab or the Bering Sea *C. opilio* fishery. Processors that enter with these more traditional operations are likely to have existing facilities that are temporarily converted to crab processing by adding a crab line. Although unallocated processing provides an opportunity for entry of processors, the ability of entering processors to compete for those shares could be limited by the ability of holders of processing shares to spread the cost of attracting Class B share deliveries across Class A share landings. The binding arbitration program, which applies only to Class A shares and which can be initiated only by harvesters, could improve the opportunity for processors without processing shares to purchase Class B share landings. By providing harvesters the unilateral ability to separate transactions for Class A share landings from Class B share landings, processors without processing shares could have more opportunity for entry.

In any case, crab harvested with open delivery shares is likely to sell for a higher ex-vessel price than crab harvested with shares that require delivery to a processor holding processing shares. Because of these two competing effects, processors might choose to enter with or without purchasing processing shares depending on their business objectives. Not allocating the entire fishery in processing shares simplifies short-term entry by processors wishing to experiment in crab markets without taking the risk of purchasing a processing share. Leasing of processing shares could also facilitate short-term entry, however, the development of that market could be hampered if processing share holders choose not to lease shares in an attempt to protect long term interests in the fishery. Unlike the harvest sector, short-term share holdings could be used by a participant to develop an interest in the fishery that could be perpetuated through the purchase of crab harvested with B shares that do not require processor shares. Processors, therefore, are less dependent on share holdings for continued participation than harvesters.

Effects of the cooperative alternative on entry to the processing sector

Analysis of processor entry under the cooperative alternative is subject to the same general market and operational complications of the other alternatives (Table 4.6-7). Processor entry could occur through a few different means; an entering processor may choose to use any or all of these means to effectively enter a

Table 4.6-1 Entry to the harvest sector under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Entry to the harvest sector	1) Latent licenses available, but price could depends on history associated with license. 2) Entry is costly since it requires purchase of a vessel, equipment, and a license.	1) Harvest shares (including C shares) may facilitate gradual entry without capital investment at the outset. 2) Cost of shares will depend on extent to which harvesters receive benefits from fisheries. 3) Liberal leasing and cooperatives could limit ability of harvesters to purchase long-term interests in the fisheries. 4) Cooperatives may limit share market.	1) Harvest shares (including C shares) may facilitate gradual entry without capital investment at the outset. 2) Cost of shares are relatively high as harvesters receive greater benefit from fisheries. 3) Liberal leasing could limit ability of harvesters to purchase long term interests in the fisheries.	1) Harvest shares (including C shares) may facilitate gradual entry without capital investment at the outset. 2) Cost of shares will depend on extent to which harvesters receive benefits from fisheries. 3) Liberal leasing and cooperatives could limit ability of harvesters to purchase long term interests in the fisheries. 4) Cooperatives may limit share market.

fishery. First, since 10 percent of each cooperative's allocation can be delivered to any processor, a processor could enter by purchasing a portion of these uncommitted landings. Entering processors may have difficulty attracting these deliveries if existing processors can effectively use a higher price on committed landings to compete for these deliveries. Second, a processor could purchase a processing license and attract cooperative members through pricing. The extent of the market for processing licenses cannot be predicted. The allocation of license to several small processors, however, suggests that licenses may be available to potential entrants. Third, a processor could enter by purchasing a license from an existing processor with a cooperative association, retaining that cooperative association. The possibility of purchasing a license with a cooperative association cannot be predicted.

Table 4.6-2 Entry to the processing sector under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Entry to the processing sector	1) Entry is not directly limited. 2) Entry requires purchase of facilities and operational expertise.	1) Entry is limited by allocation of 90 percent of the fishery. 2) Entry requires purchase of facilities and operational expertise. 3) IPQ caps and 10 percent B shares may provide opportunity for short-term or small scale entry. 4) Long-term entry depends on development of market for processing shares and share purchase.	1) Entry is not directly limited. 2) Entry requires purchase of facilities and operational expertise. 3) Harvester-only IFQ could contribute to harvester entry to processing sector.	1) Entry is limited by licensing with respect to 90 percent of landings. 2) Entry requires purchase of facilities and operational expertise. 3) Long-term entry depends on license purchase.

Notes: IFQ - individual fishing quota

4.6.1.3 Capacity in the harvest sector

One motivation for the consideration of alternative management of the BSAI crab fisheries is the need to reduce excess capacity. The affects of the different alternatives on capacity in the harvest sector is considered in this section.

Effects of the status quo alternative on capacity in the harvest sector

The current LLP management of the BSAI crab fisheries limit entry to those vessels that hold a LLP license (Table 4.6-2). In recent years, not all LLP license holders have participated in the fisheries. The rapid harvests of the allowable catch have led to very short seasons in the largest fisheries. In the smaller fisheries, such as the Aleutian Island golden king crab fisheries, fisheries can be several months long, but have progressively shortened in recent years. Pot limits have been imposed in the largest fisheries, in part, to control harvest rates to aid in the management of the total catch. These short seasons and idle licenses suggest that substantial excess capacity exists under the current management. This trend is likely to continue if the current LLP management is maintained. A few participants that currently participate may do so on the expectation that shares under a new management program will be based on historic participation. These participants may remove capital from the fishery, if continuation of current management is firmly established. The magnitude of this change cannot be predicted. In any case, substantial excess capacity is likely to persist because of the incentives created under the current management.

Effects of the three-pie voluntary cooperative alternative on capacity in the harvest sector

The three-pie voluntary cooperative alternative will substantially alter the incentives facing holders of harvest privileges in the fisheries (Table 4.6-2). Under the current LLP management, to receive a share of the catch in the fishery, a license holder must enter a vessel in the fishery. A harvester will choose to reduce capacity in the fishery only if no net return can be made from that investment. In a share based program, such as the "three-pie voluntary cooperative" program, a harvester can choose to either fish shares directly or lease those shares to another harvester for fishing. Entering a vessel in the fishery will not be necessary to obtain a return. Removal of pot limits should result in fewer vessels, each carrying more pots. Large vessels that can carry more pots are likely to be a substantial part of the fleet. Relatively smaller vessels (100 feet or less) could be used to realize operational efficiencies in some instances, but are unlikely to be the core of the fleet.[2] Cooperatives should reduce transaction costs of harvesters that may wish to make leasing decisions on an annual basis depending on total harvest levels. Capital reductions in the fishery could be constrained by landing requirements that require shares be delivered to different geographic areas. These requirements will be greatest in the first two years of the program, when the community landing requirements of the "cooling off period" are in effect.

In any case, capacity in the fisheries could be at its highest level under this alternative on implementation, before harvesters begin make decisions concerning the appropriate level of capacity. Capacity will fall quickly after implementation as several harvesters are likely to exit the fishery. After the first year or two, additional decapitalization will likely occur gradually as harvesters form relationships to facilitate the removal of even more capacity from the fishery and the fleet develops strategies to address the community landing requirements with less harvesting capacity.

Effects of the IFQ alternative on capacity in the harvest sector

Like the three-pie voluntary cooperative alternative, the IFQ alternative will substantially change the incentives facing harvesters (Table 4.6-2). Persons that have harvest privileges will not need to enter a vessel in the fishery to realize any benefit from that privilege. Capacity reductions under this alternative will be less constrained by geographic landing requirements, since the community landings requirements of the three-pie voluntary cooperative alternative are not present in this alternative. Regional landing requirements could contribute to maintaining a higher level of capacity in the fisheries, but the extended seasons likely to result under this alternative could result in these requirements having no affect on capacity. The consolidation of harvests under this alternative could be slowed by the absence of the cooperative structure; however, free share leasing should facilitate capacity reductions in the long run.

Effects of the cooperative alternative on capacity in the harvest sector

As under the other rationalization alternatives, the cooperative alternative will facilitate the removal of substantial capacity from the harvest sector (Table 4.6-2). Harvest share holders will not need to enter a vessel in the fisheries to receive a return on their shares. The cooperative structure of this alternative should facilitate rapid consolidation of harvests on fewer vessels. The absence of community and regional landing requirements could result in greater removal of capacity than under either of the other rationalization alternatives. The rules governing movement among cooperatives (particularly the one-year 10 percent share loss), however, could limit the ability of the fleet to remove vessels from the fishery in response to annual changes in total harvests.

[2] Additional discussion of fleet composition under the alternatives appears in Section 4.1.1.

Table 4.6-3 Harvester capacity under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Harvester capitalization	1) Harvest capacity remains near current level. 2) Financially stressed participants may remove capacity. 3) Some participants may remove capacity that has remained in to develop history under future share-based program.	1) Harvest capacity is reduced by coordination of harvests by harvest share holders, season extensions, relaxation of pot limits. 2) Capacity could be maintained to meet regional and processor share landing requirements and community protections (industry cooperation, both in the harvest sector and between harvesters and processors, could facilitate removal of additional capacity).	1) Harvest capacity is reduced by coordination of harvests by harvest share holders, season extensions, relaxation of pot limits. 2) Minimal additional capacity could be maintained to meet regional landing requirements (industry cooperation could facilitate removal of additional capacity).	1) Harvest capacity is reduced by coordination of harvests by harvest share holders, season extensions, relaxation of pot limits. 2) Capacity could be maintained to meet cooperative processor landing requirements (industry cooperation, both in the harvest sector and between harvesters and processors, could facilitate removal of additional capacity).

4.6.1.4 Capacity in the processing sector

This section analyzes the affects of the different alternatives on capacity in the processing sector.

Effects of the status quo alternative on capacity in the processing sector

The race for fish under the current LLP management of the BSAI crab fisheries has created a race among processors to maintain pace with landings at the end of each season (particularly in the large fisheries with the shortest seasons). As a consequence, the processing sector capacity is greater under the current management than might be required if the race for fish were slowed (Table 4.6-3). Crab processing lines are generally used only for processing crab, limiting their use for other processing. Facilities that support crab processing (such as cold storage, processing plant floor space, and housing), however, can and do support other processing activities. So, although fewer crab lines will be required under rationalization, some of the facilities that become excess might be usable for other processing activity. Low harvests in recent years, however, have led to the removal of processing equipment from the crab fisheries, much of which is currently idle. Most of the largest processors are likely to remain in the fisheries with current capacity levels under the current management. Whether processing capacity will be reduced cannot be known. Stock recovery could attract additional capacity, which is likely to come from existing crab facilities that are inactive or facilities that process fin fish that could be reconfigured for crab during the relatively short crab seasons. In the long run, processing capacity could be expected to respond to periodic changes in total harvests with substantial changes in capital that result in facilities being idle in times of low stocks and reactivated during years of high GHLs.

Effects of the three-pie voluntary cooperative alternative on capacity in the processing sector

The three-pie voluntary cooperative alternative will substantially alter the pace of harvests allowing processors to choose capacity based on efficiency rather than the need to keep pace with the race for fish. Since processors can use many of the facilities used for crab processing in other processing activities (e.g., cold storage, processing plant floor space, and housing), the capacity of the processing sector may not change dramatically, particularly at the outset of the program (Table 4.6-3). In addition, seasonality of market demands and crab quality levels may reduce the incentive of crab processors to distribute landings in a manner that minimizes capacity. Processors, however, will have less incentive to respond to changes in total harvests with changes in capacity since the race for fish will be slowed by this alternative. The allocation of processing shares will provide processors with substantial negotiating leverage for scheduling deliveries that will limit market pressure to make capacity decisions in response to harvester's landing preferences. Complying with the regional and community landing requirements under this alternative could require more processing capacity than would be required in the absence of those protections. The extent of additional capacity required because of these landing requirements cannot be predicted. The geographic distribution of landings may lead to some facilities remaining open in years of low total harvests that would otherwise close. These facilities, however, may be required in years of high harvests even in the absence of the geographic landing requirements. The cap on IPQs under this alternative could also lead to additional processing capacity from new sources in years of high total harvests. Notwithstanding these factors, this alternative should result in the removal of some processing capacity from the fisheries.

Effects of the IFQ alternative on capacity of the processing sector

Like the three-pie voluntary cooperative alternative, the IFQ alternative will substantially change the pace of fishing in the crab fisheries (Table 4.6-3). Processors should be able to respond to this change by reducing capacity in the fisheries. As under the three-pie voluntary cooperative alternative, the extent of capacity reductions cannot be determined and will not depend only on management of the crab fisheries because many facilities are utilized in other fisheries as well. Although processors would not have processing shares to leverage negotiations with harvesters under this alternative, processors would have some ability to control delivery timing through crab pricing. In the long run, harvesters will receive a greater return from their landings by facilitating efficient processing. Consequently, processing capacity levels should be expected to decrease from current levels, particularly in times of low harvest levels. Regional landing requirements could limit the removal of processing capacity at these times. The difference in processing capacity under this alternative and the three-pie voluntary cooperative alternative cannot be determined.

Effects of the cooperative alternative on capacity in the processing sector

As with the other two rationalization alternatives, the cooperative alternative will provide the opportunity for processors to reduce capacity in the crab fisheries by slowing the pace of fishing and distributing landings over a longer period of time. Structural differences of the landing requirements of this alternative, however, could affect the amount of processing capacity relative to the other rationalization alternatives (Table 4.6-3). The requirement that 90 percent of a cooperative's harvests be delivered to the associated processor could result in some additional processing capacity being maintained. This additional capacity would be maintained if harvesters are deterred from changing cooperatives by the one-year forfeiture of 10 percent of a harvester's annual allocation. The absence of community and regional landing requirements under this alternative would help facilitate the reduction of processing capacity in the fisheries. The overall affect on processing capacity in the fisheries cannot be distinguished from the other two rationalization alternatives.

Table 4.6-4 Processing capacity under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Processing capacity	1) Processing capacity remains near current level, as most large processors remain in the fisheries 2) Possible removal of capacity by some participants	1) Processing capacity could be reduced slightly but effects depend on use of capital in other fisheries 2) Additional capacity could be maintained to meet regional landing requirements and community protections particularly in times of low total harvests	1) Processing capacity could be reduced slightly but effects depend on use of capital in other fisheries 2) Additional capacity could be maintained to meet regional landing requirements particularly in times of low total harvests	1) Processing capacity could be reduced slightly but effects depend on use of capital in other fisheries 2) Capacity could be maintained to meet cooperative processor landing requirements

4.6.2 Economic efficiency in the harvesting and processing sectors

This section examines production efficiency of the harvesting and processing sectors, which is a portion of the overall economic efficiency that is used to examine the net benefits of an action. Production efficiency is a measure of the effectiveness of a producer (either a harvester or a processor) in using inputs to produce one or more outputs. Production efficiency focuses on the relationship between the quantity and quality of outputs produced and the quantity and quality of the various inputs (e.g., fuel, vessels, and labor) used for that production.[3] Two different types of efficiencies contribute to, and together constitute, production efficiency. “Technical efficiency” refers only to the production process that converts inputs to outputs and is a measure of the quantities of inputs used and the quantity of outputs produced in a production process (independent of prices and their effects). Decreasing quantities of inputs and increasing quantities of outputs are sources of technical efficiencies. “Allocative efficiency” considers of both the markets for inputs and outputs and choices of inputs and outputs and is a measure of the economic benefits of the choosing different mixtures of inputs and outputs in production. Allocative efficiency necessarily considers the costs and revenues generated by these choices. Collectively, these two types of efficiency define “production efficiency”.[4] Overall production efficiency, which is the concern of this section, therefore requires the

[3] Economists estimate four different contributions to production efficiency, all of which together constitute production efficiency:

1. Reducing the quantities of inputs used to produce a given set of outputs;
2. Increasing the quantities of outputs produced with a given set of inputs;
3. Reducing the cost of production by improving the mixture of inputs used to produce a given set of outputs; and
4. Increasing revenues by improving the mixture of outputs produced using a given set of inputs.

The first two of these estimates are "technical efficiency" and refer only to the production process that converts inputs to outputs (rather than the markets for inputs and outputs). The later two measures are "allocative efficiency" and require consideration of both the markets for inputs and outputs and choices of inputs and outputs.

[4] See appendix 2-7 to the RIR, which is appendix 1 of this document, for a more complete description of these different types of efficiency.

consideration of both the choices that the producer makes in the markets for inputs and outputs and the process by which inputs are converted to outputs. In the end, overall production efficiency may be measured by the returns to producers – the difference between the producer's revenues generated by outputs and the producer's costs of inputs.

Since the output of the fishery is crab products (e.g., crab sections), an analysis of overall efficiency would assess the efficiency of both the harvest of crab and the processing of crab into crab products. The Council's problem statement, however, recognizes that production in the fisheries is generally separated into two sectors – harvesting and processing – and expresses its intent that the rationalization program contribute to the economic stability of both sectors. To facilitate an understanding of the implications of the alternatives on these two sectors, this analysis separately assesses the implications of the different alternatives on the efficiency of the two sectors.[5]

To develop an understanding of production efficiencies under the alternatives, it is helpful to develop a framework for assessing returns to producers in the fisheries and the sources of those returns. Three different sources contribute to returns to producers in the fisheries; resource rents, harvester normal profits, and processor normal profits. First, crab that will be harvested and processed has an scarcity value while unharvested in the water that is realized by harvesting and processing. This value can be said to exist independent of the action of harvesters and processors. Once the crab is harvested and processed, this value is captured by the industry. The value referred to here is the resource rents, or the value of crab in its natural state that is realized only by the harvesting and processing of the crab.[6] In large part, the ex vessel price represents the division of resource rents between the two sectors. This value, however, is only one part of the returns realized through the harvesting and processing of crab.

In addition to resource rents, each sector is generally expected to receive its normal profits (or a reasonable return on investment in the industry). The normal returns on harvesting investments and normal returns on processing investments are the other two sources of returns in the fisheries. As in any business, harvesters and processors invest capital and effort on the reasonable expectation of receiving a return on that investment. Normal profits, however, may not be earned during transitional periods. Transitional periods could occur because of changes in the total harvests, economic conditions that affect product markets, or regulations governing the fishery. These changes in circumstances can lead to unexpected effects on the returns to participants. The prevalence of changes in annual total harvests of crab fisheries are particularly problematic for this reason, since long term planning can be disrupted by those changes. Harvesters and processors that invest based on returns observed in seasons of high harvests may not receive the return they expect (and could suffer losses) as a result of drastic stock declines. In assessing the distribution of revenues and efficiencies under the different alternatives, the ability of the different sectors to respond to these changes and the ability of one sector to impose the cost of unexpected changes on the other sector must be assessed.

[5] The analysis later summarizes overall efficiency in production from the fisheries (which is the combined efficiency of harvesting and efficiency of processing) allowing the reader to assess of the contribution of production to net benefits of the different alternatives.

[6] Note that the value being referred to here is not the entire value of the crab, but only that value that is realized through harvesting and processing. Frequently (and later in this document) economists consider other values of a resource, such as the non-use value derived from the resource remaining in its natural state.

When assessing the efficiencies in this section, one must keep in mind the relationship between resource rents and efficiencies. In a more efficient fishery, a greater portion of the rents of the resource will be captured by the fishery participants. For example, ending a race for fish may slow the flow of crab through processing plants, increasing product recovery, which increases returns from the fishery. This capture of additional rents could result in relative improvements in both sectors, if the efficiency gain is shared between the sectors. The discussion of efficiencies is largely an analysis of the capture and distribution of the resource rents between the two sectors. The reader should bear in mind that in a fishery in which the division of revenues moves to the detriment of one sector, that sector does not necessarily suffer a decline in efficiency (and hence may not be made worse off), if substantial efficiencies are realized (or in other words, substantial additional rents are captured). If total revenues in the fishery rise substantially, even a negative shift in the division of revenues could leave a party more efficient and better off.

The analysis also considers the affects of the different alternatives on efficiency during times of transition, particularly on implementation of the alternative and during times of low total harvests. The ability of the different sectors to capture resource rents and receive normal profits during transition periods is also discussed.

As should be apparent from this discussion, a critical factor in the assessment of the effects of the alternatives on efficiency of the harvesting and processing sectors is the ex vessel price of crab, which represents the distribution of crab product revenues between the two sectors. Crab landings generate revenues for harvesters and are a principal input costs to processors. Because of the importance of crab prices in determining the efficiencies of the different sectors, the analysis in this section devotes considerable attention to the effects of the different alternatives on the distribution of revenues between the sectors (which is reflected in ex vessel prices).

The analysis presented in this section examines the alternatives in an order slightly different from the previous sections. The status quo alternative is analyzed first, followed by the IFQ alternative, then the three-pie voluntary cooperative alternative, then the cooperative alternative. The reason for this change is that the analysis of the IFQ alternative is helpful to understanding the three-pie voluntary cooperative alternative and the cooperative alternative.

4.6.2.1 Economic efficiency in the harvesting sector

This section analyzes efficiency changes in the harvest sector under the different alternatives. Recall that the efficiency examined in this section is production efficiency, which differs from overall economic efficiency that is used to examine the net benefits of an action. Production efficiency focuses on the relationship between the quantity and quality of output produced and the amount and quality of the various inputs (e.g., fuel, vessels, and labor) used for that production. Production efficiency examines the effectiveness of a producer in using inputs to produce one or more outputs, comparing revenues and costs, thereby providing a measure of overall economic condition of the sector under the alternative.

This section focuses on the production of crab by harvesters – harvest and landing of crab – and the variation in production efficiency under the different alternatives. The product output of the harvest sector under all of the alternatives is live crab delivered to a processing facility. Since harvest allocations are fixed by regulation, the discussion of the effect of outputs on efficiency focuses on prices.[7] Crab harvesters rely on

[7] In assessing the production from the fisheries, it is important to bear in mind that harvesters may contribute to the product outputs of processors through cooperation with processors. For example, a processor may not be capable

several inputs, including fuel, captains and crew, vessels. The alternatives do not directly affect the markets for these goods and services and are likely to have little predictable effect on the prices of these goods and service. As a result, the analysis of the alternatives on inputs and their efficiency effects focuses on the quantities of those inputs used in production (or technical efficiencies).

Effects of the status quo alternative on efficiency in the harvest sector

An understanding of harvest sector efficiencies under continuation of the current management is best attained by examining the current status of the fisheries. The current LLP management limits entry to the fisheries and total harvests by the fleet but does not apply any harvest limitations at the individual or vessel level (Table 4.6-1). In the competitive fishery that has developed, each harvester has an incentive to increase inputs to the level where the increase in revenues derived from those inputs equals the cost of those inputs. A harvester receives no compensation for not participating in years of low total harvests, so harvesters are compelled to participate. Since participation requires vessel and crew costs that far exceed marginal returns to the fishery overall, the individual participation choice may decrease technical efficiency and dissipate rents in the fishery overall. In the race for fish, the use of technologies that increase harvest rates is rewarded. For a harvester to increase (or even maintain) its share of total harvests it must tailor its efforts to harvesting crab quickly, rather than cost effectively. Harvesters use relatively short soak times for pots, increasing the amount of effort by crews and fuel consumption in deploying and retrieving gear. Bycatch of undersized and female crab is increased since short soak times limit sorting by gear escape mechanisms, increasing sorting by crews. The technical inefficiency in harvesting is reflected by the relatively short seasons in the fisheries that are currently open. In recent years in the Bristol Bay red king crab fishery, seasons have been as short as a few days. In the Bering Sea *C. opilio* fishery, seasons have been as short as a few weeks. Although typically longer, seasons in both of the Aleutian Islands golden king crab fisheries have declined in length in recent years. The amount of harvest sector technical efficiency sacrificed under continuation of the current management cannot be predicted, but is likely substantial.

Technical efficiency also suffers because of the low level of total harvests. The rational response of participants in the harvest sector to transitions, particularly declines in total harvests, is detrimental to harvest efficiency. Since harvesters cannot realize any returns without participating under the current management, in periods of low total harvests a harvester's best response may be to maintain (or possibly even increase) harvesting power in an attempt to maintain or increase its share of the total harvest. This compounds the expected decline in technical efficiency that would result from scale effects, causing an even greater loss of efficiency in periods of low total harvests.

Harvest efficiency is also affected by the price received for landings. In the current derby-style fisheries, the ability of harvesters to negotiate ex-vessel price is limited by the time constraints on harvest landings (Table 4.6-5). Since the competitive fisheries close once the GHL is reached, in the one landing fisheries' harvesters line up at processing facilities waiting for their harvests to be offloaded. Because crab must be processed live, harvesters have a limited ability to hold deliveries for a better price. So, although processor competition is not directly limited under the current management, the limited time available for harvesting and offloading

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of producing fresh or live crab without coordination of deliveries with harvesters that allow the processor to deliver product to markets without loss or spoilage. If the contribution of harvesters to the development of different products by processors is rewarded with a price increase that exceeds the harvesters additional costs for the coordination of those deliveries, harvesters realize an efficiency improvement.

crab has the effect of limiting competition among processors for harvest landings. The magnitude of any limit on competition among processors cannot be estimated.

Despite the time constraints that have limited processor competition, harvesters have utilized their ability to cooperate to leverage a better price in some fisheries. Since the early 1990's, the Alaska Marketing Association (AMA) has represented a substantial share of fishers in price negotiations in the largest BSAI fisheries– the Bristol Bay red king crab, the Bering Sea *C. opilio*, and the Bering Sea *C. bairdi* fisheries. In this process, AMA solicits prices from all major processors. Prices that representatives believe could be acceptable to members are submitted to a vote by AMA members. Typically, other processors in the fishery have matched any accepted price.[8] In the past, harvesters have organized delays in fishing (i.e., strikes) to pressure processors to make higher price offers. The effectiveness of these delays is limited in part by catcher/processors that have not abided by the delays. In addition, delays are likely to have limited effectiveness since harvesters have no opportunity to use their vessels for other purposes. In more recent seasons, the AMA has organized members to reward the processor that offered the accepted price with additional deliveries. This second method of inducing a higher price offer is likely more effective, since the additional deliveries provide the processor offering the high price with a competitive advantage. The strength of this inducement, in the long run, depends on the willingness of processors to compete for additional deliveries, which is difficult to predict.

Traditionally, participants in the smaller, less capitalized BSAI crab fisheries have negotiated prices independently. For example, only recently have harvesters in the Aleutian Islands golden king crab fisheries used collective action to negotiate ex-vessel prices for the fleet. Notwithstanding these efforts, some harvesters continue to negotiate prices for their harvests independent of any collective negotiations. Longer seasons in the Aleutian Island golden king crab fisheries allow for substantial in-season price fluctuations, which are uncommon in the short season fisheries. The longer seasons with fluctuating prices have also complicated organizing collective action in these fisheries.

To an unknown extent, price negotiations and delivery patterns are influenced by relationships between harvesters and processors. Some harvesters tender salmon and herring for processors. Maintaining this contract might require the harvester to continue to deliver crab to the processor. Similarly, some harvesters receive financial support from processors. Whether formalized or not, some of these harvesters have a perceived obligation to deliver crab harvests to the processor with whom they have a financial relationship. The extent of the impact of these relationships and obligations on prices and delivery patterns is not known, but these factors likely impact ex vessel prices and efficiencies of some participants in the current fisheries.

If the status quo management of the fishery is maintained, current pricing practices are likely to continue. Harvesters are likely to continue to use collective action and inducement of additional deliveries to solicit higher price offers from processors in the large, highly competitive fisheries. As effort continues to increase in the Aleutian Islands golden king crab fisheries, harvesters in that fishery could begin to use similar methods of price negotiations. Ex vessel prices will depend in part on the level of competition and capitalization in the processing sector. Under current management, the crab fisheries support only a few weeks or months of operation each year. At current harvest levels, the processing sector appears fully

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[8] Notwithstanding the solicitation of a fleetwide price by industry, some processors have offered prices other than the price accepted by the AMA. In most cases, these price differences arise from differences in distance from the processing facility to the fishing grounds, availability of goods and services, the provision of services by processors, and other factors. For example, Kodiak processors have offered a slightly higher price, which could be to compensate harvesters for the additional distance to that port from the fishing grounds.

capitalized. In addition, capital recently removed from the processing sector could be quickly reintroduced if harvest levels increase. Most of the current processors rely on both crab fisheries and other fisheries to support their processing operations. Since those other fisheries are also fully capitalized, substantial change in competition in the processing sector is unlikely, if current management is maintained. Consequently, the distribution of revenue are expected to remain unchanged in the future.

Overall harvest efficiency under the status quo alternative is likely to remain at current levels with technical efficiency sacrificed due to the race for fish and a continuation of current ex vessel pricing practices.

Effects of the IFQ alternative on efficiency in the harvest sector

The IFQ alternative is likely to improve efficiency in the harvesting sector over the current LLP management (Table 4.6-1). The allocation of harvest shares will alter the incentives facing harvesters prosecuting the fisheries. A harvester's share of the fishery will generally be unaffected by its harvest rate. Instead, harvesters will be able to refocus their efforts toward harvesting allocations in a manner that improves technical efficiency – reducing inputs and increasing the quality of crab delivered to the processors, provided that quality improvements are rewarded. In the short run, harvesters are likely to focus on the reduction of variable inputs, such as fuel, crew, and insurance costs. Although seasons will still be limited to protect crab during molting and mating and possibly to facilitate management and oversight, harvest time is unlikely to constrain harvesters. Relaxing pot limits could permit harvesters to use more pots (and perhaps fish in ways that fewer pots would be lost) and reduce crew sizes slightly in a rationalized fishery (to realize allocative efficiencies). Vessels will likely be removed from the fleet to save on these variable costs. Some vessels may be deployed in other fisheries or uses, but the extent of these outside opportunities may be limited. Free share trading under the program should also contribute to efficiency gains, as harvesters able to fish most efficiently will be able to purchase and fish the shares of less efficient harvesters. The realization of efficiency gains could be limited by the regional landing requirements of this alternative, but the absence of community landing requirements and the right of first refusal to community groups should contribute to greater harvest sector efficiency than that of the three-pie voluntary cooperative alternative. Similarly, the absence of any direct processor protection (i.e. processor shares or other processor landing requirements) should allow harvesters to balance the efficiency gains of processor provision of goods and services against ex-vessel prices, when transacting with processors. A harvester may choose to sacrifice technical efficiency (i.e., use more inputs such as fuel) by delivering to a processor that is willing to pay a greater price. This trade off may result in less technical efficiency gains in the harvest sector, but gains to the harvester overall through the higher price (i.e., greater overall efficiency in production for the harvester).

Harvesters are also likely to realize an efficiency gain through ex vessel pricing under this alternative. A primary difference between the status quo alternative and the different rationalization alternatives is the slowing of the fishing pace (Table 4.6-5). This slowing of the race for fish not only affects the ability of harvesters to realize technical efficiencies, but also affects price dynamics between the harvesting and processing sectors because the timing of harvests and landings will no longer be constrained by the race for fish. In a harvester-only IFQ program, harvest share holders will have the greatest leverage in negotiating deliveries with processors. Processors, unprotected by any limit of entry, will be forced to compete for deliveries, and possibly accommodate the delivery preferences of harvesters. As a consequence, harvesters can be expected to receive the greatest share of the resource rents and have the greatest efficiency under this alternative.[9] Processors could have some extraordinary negotiating leverage because entry to the processing sector is limited by operational complexities of operating processing plants in remote Bering Sea locations, but this leverage is likely to be less than the negotiating leverage of harvesters created by the harvest share allocation.

In general, vertical integration of the industry will decrease competition for landings to the detriment of independent harvesters (or harvesters that are not affiliated with processors). Vertical integration reduces any dependence of processors on harvesters for landings and provides additional information to processors that can be used in negotiations. Under this alternative, processors that are permitted to acquire harvest shares may choose to increase vertical integration to protect their share of the market for harvest landings. Doing so would decrease competition for harvest share landings from independent processors. Similarly, relatively large harvesters may choose to vertically integrate in an attempt to realize greater returns. In either case, the coordination of the two sectors could result in greater overall (harvesting and processing) efficiency, but could reduce efficiency to harvesters that are not vertically integrated, who might lose some negotiating leverage with processors. The extent of these practices cannot be predicted. Independent harvesters, however, would continue to be relatively more efficient under this alternative because of the negotiating leverage of the harvest share allocation and the absence of direct processor protections.

In times of transition, such as the implementation of the program and at times of large declines in total harvests, processors may be forced into intense price competition to protect the market share. If crab supplies unexpectedly decline, ex vessel prices are likely to rise (with a relative gain in efficiency to the harvest sector). Harvesters will be in a relatively better position because their interests in the fishery will be protected by the harvest share allocation. Processors, on the other hand, will have excess processing capital relative to the crab harvest and should be expected to compete for market share driving up the ex vessel price (with a commensurate improvement in harvest sector efficiency).

Although ex vessel prices could rise during transitions, particularly periods of low total harvests, harvester technical efficiency (and overall efficiency) could be reduced because additional inputs may be required to harvest each crab due to scale effects. The ability of harvesters to coordinate deliveries (because of free leasing and transfer of shares and the absence of processor share landing requirements and the limitations of community protections) should mitigate these decreases in harvest sector efficiencies. The absence of the emphasis on cooperatives under this program could lead to less coordination, particularly by holders of relatively small harvest allocations that choose not to work with others. The effects transitions on harvest sector participants is likely to vary and depend on the differences in the abilities of the participants to respond to the transition. In times when total harvests decline, harvesters with small share allocations or that are in weak financial positions are most vulnerable to these changes and could be forced to exit the fisheries. Exiting harvesters will hold shares to divest, providing some compensation that will reduce the negative impacts. Harvesters remaining in the fisheries will also suffer from declines in total harvests, but will be relatively better off than processors because of the allocation of harvest shares. The harvesters that will suffer the most during periods of stock declines are those that have purchased shares based on long term projections of returns from the fisheries as their investment expectations go unrealized or are delayed.

9 Under all of the rationalization (or share-based) alternatives, the resource rents that flow to share holders would be captured by the recipient of the initial allocation of shares. Generally, the price of the shares in trade will reflect the rents embodied in the shares.

Overall, the ability to coordinate harvest activity and remove vessels from the fleet without loss of harvest share, together with a relative improvement in bargain strength arising from that allocation should result in substantial improvements in harvest sector efficiency over the status quo.

Effects of the three-pie voluntary cooperative alternative on efficiency in the harvest sector

Harvesting practices are likely to change substantially under the three-pie voluntary cooperative alternative (Table 4.6-1). As under the harvester only IFQ alternative, harvest share allocations will enable harvesters to reduce inputs used to harvest their fixed allocations improving technical efficiency. Free trading of shares, subject to individual use caps, under the program will aid in facilitating these efficiency gains by allowing more efficient harvesters to purchase the shares of less efficient participants and consolidation of shares on fewer vessels. The effects of this alternative on harvest sector efficiency will differ from the IFQ alternative because of the allocation of processing shares and two different types of harvest shares; Class A harvest shares that require delivery to a processor that holds processing shares and Class B harvest shares that can be delivered to any processor. Under this alternative, Class A shares would be allocated for 90 percent of the TAC, while Class B shares would be issued for 10 percent of the TAC. The potential effect of these different share allocations on harvest sector efficiencies is discussed throughout this section.

Harvest sector technical efficiency gains under this alternative are expected to be reduced by the regional and community landing requirements and the community right of first refusal on processing shares. For example, harvesters required to deliver to remote communities to meet community landing requirements could need to travel to less remote ports for services that might be unavailable in the remote communities. Technical efficiencies might be improved if harvesters were able to concentrate landings in locations that minimize harvest costs. Instead, the regional and community landings requirements, which are likely to disburse landings geographically, could reduce efficiencies by requiring the fleet to make deliveries in several different locations. The extent of any decrease in efficiency gains cannot be predicted and will likely vary with several factors including stock levels and the geographic distribution of stocks in the fisheries. In addition, the ability of the industry to respond to these landing requirements cannot be predicted. If harvesters coordinate operations (particularly across cooperatives that may hold shares in different regions) any efficiency loss could be reduced. For example, in a season of high total harvests if one cooperative holds shares that require delivery to a processor relatively close to the fishing grounds, while another holds shares for delivery for a more distant processor, inputs may be reduced by the cooperatives trading shares to allow in season deliveries to the nearby processor, with each harvester making a single end of season delivery to the processor more remote from the fishing grounds. In part, the technical efficiency losses arising from these landing requirements could be determined by the willingness and ability of the industry to respond creatively.

Since the community landing requirements of the "cooling off period" will lapse after two years, the impacts of those provisions on efficiency will be limited. Since the regional landings requirements are a permanent part of the program, the effects of those requirements will continue for the duration of the program. The right of first refusal on processing shares is intended to provide community groups with a mechanism to retain historical processing activity. The effects of this provision on harvest efficiency depend on whether community groups are able to leverage the right to retain processing that would depart the community and consolidate in other areas. Since the provision has exceptions that would allow processing to leave a community without being exposed to the right of first refusal and the right of first refusal expires if not exercised on the first sale of the shares for use outside the community, the long term effects of this provision could be limited. Yet, if community groups show a willingness to exercise the right, the affects could be lasting.[10]

The landing requirements of the processing shares could also limit the ability of harvesters to realize technical efficiency gains. Since harvest landings are dependent on the processor location, it is possible that processors may choose to process in locations that reduce harvest technical efficiency gains.[11] Some impacts on harvest efficiencies could depend on processor practices, particularly with respect to the provision of fuel, bait, and services. For example, if remotely located processors decide not to provide these goods and services to delivering vessels, harvest sector efficiencies could be impacted greatly. The technical efficiency effects of processor provision of goods and services could depend on whether the arbitration program creates an incentive for processors to provide goods and services by requiring a higher ex-vessel price, if goods and services are not provided. If ex-vessel prices are affected by the provision of goods and services, in the long run, processors are likely to realize higher returns by aiding harvesters' realization of technical efficiencies.[12]

The cooperative structure of this alternative may aid harvesters in improving technical efficiency by fleet members working together. Two competing effects of the voluntary nature of the cooperative program could impact of the alternative's effect on harvest efficiency. First, since cooperative membership is voluntary, harvesters that have a preference for maintaining an independent operation may realize less efficiency gain. This independence is likely to be overcome with time, if gains in efficiency can be realized by cooperative action. The voluntary structure of cooperatives, however, could contribute to efficiency gains by allowing harvesters to enter different cooperatives in different fisheries, enabling greater efficiency gains than a structure that limits a harvester to a single cooperative in all of the fisheries that it participates.

The 10 percent B share harvest allocation could also affect harvester technical efficiency. These shares are likely to be harvested simultaneously with the A shares, which require delivery to a processor holding processor shares. If delivery to some processors would increase harvester technical efficiency (through input cost reductions), we might expect the B shares to migrate to those processors.[13]

Technical efficiency in the harvest sector is likely to be lowest during times of transition, particularly when total harvests are low. Community, regional, and processor landing requirements could disburse landings adding substantially to harvester inputs. Coordination of harvesting by cooperatives could aid technical efficiency. If processors are willing and able to engage in custom processing that consolidates processing

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[10] Whether these purchases would have an effect on the harvest sector could depend on whether the arbitration process allows harvesters to recover the added costs in the ex-vessel price. Delivery location is a factor to be considered by the arbitrator, but the specific effects cannot be predicted.

[11] Although the costs to harvesters may rise as a result of these processing choices, the net return to harvesters may be unaffected, if harvesters recover these added costs in ex-vessel revenues. Net returns are discussed in a later section of this document.

[12] In the event that processors do compensate harvesters with higher ex vessel prices in the absence of providing goods and services, the loss in technical efficiency would be mitigated or overcome to the extent of the price compensation.

[13] Harvesters may choose not to use their B share harvests in the most technically efficient manner, if they can leverage a better price on A share deliveries with those B shares (improving overall harvester efficiency through a price improvement). In the end, harvesters can be expected to use their B shares in the manner that provides the greatest overall harvester efficiency on all landings. The extent of the effect of B shares on harvest efficiencies, however, cannot be predicted, but is likely to be limited due to the relatively small size of that allocation.

during these periods, harvest technical efficiencies could be less affected. The decision of processors to engage in this consolidation is likely to depend on several factors, including its effects on ex vessel prices and processor efficiencies, and cannot be predicted. Although technical efficiencies are likely to suffer in times of low total harvests, harvester technical efficiency under this alternative should be better (or at least no worse) than under the status quo alternative.

Harvester revenues are also an important component of harvest sector efficiency. Several factors are likely to affect the ex vessel price under the three-pie voluntary cooperative alternative (Table 4.6-5). As under the IFQ alternative, the race for fish would be slowed by the allocation of harvest shares. Yet, the effects of this alternative on price will differ significantly from the IFQ alternative because of the allocation of processing shares and two different types of harvest shares; Class A harvest shares that require delivery to a processor that holds processing shares and Class B harvest shares that can be delivered to any processor. Although a relationship between the two share types will likely exist, an understanding of the ex vessel prices in the fisheries is gained by examining the different share types separately, then examining their relationship.

Because of the structure of the arbitration program, harvesters are likely to capture a relatively larger share of the resource rents for crab harvested with Class B shares than for crab harvested with A shares. Arbitration is undertaken only at the harvester's election and applies only to A share deliveries. Consequently, a harvester can negotiate deliveries of B shares independently from deliveries of A shares, by threatening arbitration if the processing share holder attempts to intertwine negotiations of A share and B share deliveries. Providing harvesters with the ability to negotiate B share deliveries separately from A share deliveries makes B shares equivalent to IFQ in a harvester-only IFQ program. Processor entry, however, could be more limited under this alternative than under the harvester-IFQ program, in which case, processors might capture more of the resource rents on B share landings than on the landings of crab in a harvester-only IFQ program because of the reduced competition.[14]

Processing share landing requirements limit the market for A share landings. As a consequence, the distribution of revenues of landings of crab harvested with A shares will depend greatly on the arbitration program, the outside opportunity for harvesters that are dissatisfied with the outcome of price negotiations. Although arbitration may take place in few instances, the threat of arbitration and the expected arbitration price are likely to drive the outcome of negotiations. The arbitration standard provides that the historic division of first wholesale revenues should be maintained for the landings of crab harvested with A shares. Assuming no change in the total benefits derived from the fisheries, this standard would preserve the historic distribution of benefits for A share landings. Whether the standard will have that effect cannot be determined and is likely to depend on several different factors. If processed product revenues are improved through product improvements and developments (capturing greater rents), both sectors could share those additional rents. The arbitration standard would likely provide for the sharing of these revenues between the sectors with the division influenced by the contribution of the parties to the product developments and improvements. In addition, the arbitration standard provides that the arbitrator can consider any relevant evidence in making an arbitration decision, including negotiated prices for both A share landings and B share landings. Although this breadth of discretion could be necessary for fairness, it also makes the standard less predictable.

Another factor that could affect the distribution of product revenues to harvesters for A share landings is the ability of harvesters to leverage a higher A share price using B share landings. If harvesters are able to drive

[14] The cap on IPQs (which also operates as a cap on A shares) could add to harvester negotiating leverage in years of high total harvests. The extent of this effect depends on total harvests, which are very hard to predict.

processors to compete for B share landings by increasing the price for A share landings, it is possible that harvesters could derive more revenues from A share crab than the historic division of revenues.[15] It is also possible that these elevated A share landings prices will be considered by the arbitrator in determining arbitrated prices. If so, the distribution of revenues to harvesters for A share landings could be greater than the distribution that would be derived from the historic division of revenues. At the outset of the program, the division of revenues from A share landings is likely to be similar to the current distribution of revenues in the fisheries. Over time, the division of revenues may change as the industry changes under the new management. As a result, the division of revenues for A shares is difficult to predict.

In general, vertical integration of the industry will decrease competition for landings to the detriment of independent harvesters (or harvesters that are not affiliated with processors). Vertical integration reduces any dependence of processors on harvesters for landings and may provide additional information to processors that can be used in negotiations. The allocation of B shares to independent harvesters only, however, should counter some of this dampening effect on competition. Since the B shares will always constitute 10 percent of the total share allocation, the percentage of shares held as B shares by independent harvesters will increase as vertical integration increases. These additional B shares will increase the market power of independent harvesters because processors will need to compete for the B share landings.[16]

During transitions, particularly on implementation and in years of low total harvests, harvester efficiency will be relatively low. On implementation, relationships and delivery coordination could be slow to develop resulting in relatively low harvesting efficiency, in comparison to later periods under the program. Share matching in the first few years could result in substantial inefficiencies if participants in both sectors are reluctant to lease shares to others to achieve efficiencies while complying with the one-to-one match required of A shares and processing shares. Regional and community landing requirements will compound the coordination problem, since they require a relatively wide geographical distribution of landings. Some harvesters could be disadvantaged greatly, if delivery of a single load is required to be divide among different locations. Low total harvests in the current fisheries will compound this problem. The structure of the arbitration program, which creates an incentive for matching shares and settling prices before or early in the season, should help overcome this potential loss of efficiency. Cooperatives and free transferability of shares should also reduce efficiency losses. Overall, the technical efficiencies that result from the slowing of the race for fish are likely to fully counter (and possibly exceed) these coordination inefficiencies.

During times of transition, participants in both sectors will be protected to some extent by their share holdings. Although the financially weakest participants could be forced to exit, divestiture of shares will provide some compensation. Transitions could also affect the negotiating strength of the different sectors. Since the 10 percent allocation of B shares is a relatively small allocation the ability of harvesters to use these shares for negotiating leverage is likely to be substantially less in times of low total harvests. Consolidation of these shares in cooperatives will aid harvesters in using these shares for negotiating leverage to some extent, but on the whole, harvester negotiating strength from B shares can be expected to be at its lowest at times of low total harvests.

[15] The experimental analysis of the arbitration program suggests that harvesters could develop this competition under an arbitration program that uses a binding fleetwide arbitration price. Whether a similar result could be achieved under the non-binding fleet wide arbitration cannot be predicted.

[16] If the fisheries were to become over 90 percent vertically integrated, the allocation of B shares would be less than 10 percent, but all independent harvesters would receive only B shares.

As under all of the alternatives, harvesters that have relatively small allocations and harvesters that have purchased shares with an expectation of returns from those shares will suffer the most during times of low total harvests. These harvesters are likely to suffer more under this alternative than under the harvester-only IFQ because processing competition is limited by both the processing share protection and the relatively small allocation of B shares. Inefficiencies of community protections and regional landings requirements could compound these negative effects in some cases. Specific circumstances of the harvesters involved are likely to determine the extent of any losses of efficiency during these transitions.

Overall, harvest efficiency should improve (or at least remain unchanged) in comparison to the status under this alternative. The allocation of shares to harvesters will contribute to efficiency, but this will be offset to some extent by the allocation of processing shares and the regional and community protections. The effects of the arbitration system should counter the effects of processing shares in the price determination process to some extent, providing harvesters with protection against potentially unfair pricing by processors.

Effects of the cooperative alternative on efficiency in the harvest sector

As under the other rationalization alternatives, the allocation of harvest shares under the cooperative allocation will allow harvesters to tailor efforts to reduce harvest inputs (Table 4.6-1). The change in incentives should lead to increased technical efficiency in the harvest sector. Share trading, both within and across cooperatives, could also contribute to efficiency gains in the fishery, as more efficient harvesters are able to purchase shares of less efficient harvesters.

Technical efficiency gains could be realized within cooperatives, those gains are likely to be limited by the cooperative structure of the alternative. The requirement that a harvester belong to a single cooperative, which would deliver 90 percent of its landings to a single processor, could limit the ability of a harvester to realize technical efficiencies. For example, harvester responses to changes in harvest levels caused by stock fluctuations may be limited. Although harvesters can respond to changes in efficiencies by changing processors, the forfeiture of 10 percent of a harvester's shares on changing cooperatives without consent of the associated processor could deter a harvester from changing cooperatives to reduce input costs.[17] These forfeitures could have both short term and long term effects depending on the magnitude of potential technical efficiency gains that would arise from the change of cooperatives.

As under the three-pie voluntary cooperative alternative, processors could also impact harvester technical efficiencies by providing goods and services (such as fuel and pot storage) to harvesters. Efficiency of the sector could be impacted, if harvesters are compelled to use fewer inputs if processors provide these goods and services. These effects could be increased since harvesters will be able to unilaterally change processors by forfeiting 10 percent of an annual allocation. The forfeiture, however, could deter technical efficiency gains that might be realized in its absence.

As under the other rationalization alternatives, the allocation of harvest shares and the consequent slowing of the race for fish will affect ex vessel prices under the cooperative alternative (Table 4.6-4). Yet, the allocation of shares exclusively to cooperatives, together with the processor protections make the distribution of revenues under this alternative difficult to predict. A cooperative is required to delivery 90 percent of its allocation to the associated processor. Yet, a harvester can unilaterally move among cooperatives by forfeiting 10 percent of their annual allocation to the cooperative that it left in the following year. This ability

[17] The ex vessel price effects of the cooperative structure on efficiency are discussed later in this section.

to move unilaterally, means that processors must pay a price high enough such that the one-year, 10 percent share loss will not be quickly recaptured by the harvester in the new cooperative after the move. Since several processors will be granted licenses under the program, the opportunity for harvesters to move among cooperatives should exist.

The distribution of revenues will also be affected by the ability of cooperatives to deliver 10 percent of their landings to any processor. These shares are similar harvest shares in a harvester-only IFQ alternative. Cooperatives, however, are likely to attempt to use these shares to negotiate a higher price for the shares that must be delivered to its associated processor. If so, these landings may be at the same ex-vessel price as landings that must be made to the associated processor, but with an overall increase in harvester efficiency.

Another factor that must be considered is the distribution of revenues in the year before implementation of the program. At the onset of the program, each harvester will be permitted to join a cooperative associated with the processor to which it delivered the most pounds of crab in the year prior to implementation. This method of determining associations has the potential to lead to intense competition among processors in the year before implementation, shifting the division of revenues toward harvesters in that year. Since 90 percent of a cooperative's allocation will be required to be delivered to its associated processor, developing a large associated cooperative fleet could be of benefit to a processor. In the year prior to implementation, it is possible that processors would compete very aggressively to create these associations. This shift in revenues will occur only in the year before the program. Once implemented, the distribution of revenues will be determined by the landing requirements and the effects of movement between cooperatives on annual allocations. Whether a processor will be able to recapture revenues through the cooperative association is uncertain. Long term contracts would seem to be an effective way for both parties to limit risks that arise from this competition and the resulting association. Whether parties might use contracts to limit risk cannot be predicted.

The overall affect of this alternative on the distribution of revenues between the harvest and processing sectors will depend on whether the shift in market leverage that arises from the allocation of harvest shares and the end of the race for fish is counter-balanced by the processor protections of the cooperative structure. The different impacts of these factors cannot be predicted.

The effects of transitions on the distribution of revenues will also depend on several factors. Two competing effects are likely to arise because of the structure of this alternatives. First, the 10 percent allocation to each cooperative that can be delivered to any processor will provide relatively less negotiating leverage in times of low total harvests. Countering this effect, the one-year 10 percent forfeiture for moving between cooperatives will be relatively low in years of low total harvests, providing harvesters that are willing and able to exploit a possible move with greater negotiating strength. The outcome of these competing effects cannot be fully predicted and will likely depend on circumstance of the participants and in the fisheries in general.

Transitions, particularly reductions in total harvests, are likely to reduce efficiencies in the harvest sector under the cooperative alternative. The extent of these reductions is hard to predict and likely depends on the circumstances of participants in the fisheries. If cooperatives are well coordinated and inter-cooperative arrangements are easily arranged (and permitted by processors), the reductions in harvest sector efficiencies could be minimized. On the other hand, if cooperatives are structured to exploit potential efficiency gains and cooperatives are reluctant to engage in inter-cooperative harvest arrangements, efficiencies could be greatly affected. So, efficiency is likely to be reduced in times of low total harvests and other transitions, but the extent of those changes depend largely on the willingness and ability of participants to overcome potential reductions in efficiency.

Overall, this alternative is likely to improve on (or at worst maintain) harvest sector efficiency in comparison to the status quo alternative. Harvest share allocations will contribute to improvements in technical efficiency. Although the impact of the alternative on ex vessel prices is uncertain, any negative price effect is likely to be less than or equal to the gain in technical efficiency.

Table 4.6-5 Harvester efficiency under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Harvester efficiency - revenues less costs	Harvester efficiency remains at current level - efficiency is sacrificed by the race for fish.	1) Harvester efficiency improves with allocation of harvest shares and end of the race for fish. 2) Efficiency may be reduced by regional and processor share landing requirements and community protections (industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss). 3)Processor shares limit market for landings. 4) Arbitration has ex vessel pricing effects.	1) Harvester efficiency improves with allocation of harvest shares and end of the race for fish. 2) Efficiency may be reduced by regional landing requirements. 3) Market for landings is unrestricted by processor landing requirements.	1) Harvester efficiency improves with allocation of harvest shares and end of the race for fish. 2) Efficiency may be reduced by cooperative processor landing requirements (industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss). 3) Cooperative landing requirements and structure limits market for landings.

4.6.2.2 Economic efficiency in the processing sector

This section compares processor efficiency under the different alternatives. As noted earlier, efficiency is a measure of the difference between the total costs of inputs to the sector and the total revenues generated by the production of the sector. The alternatives affect a few primary factors in the processing sector. First, if processors can realize technical efficiency gains by reducing the quantity of inputs relative to the quantity of outputs. Product recovery improvements and reductions in inputs could both contribute to these efficiencies. Second, processors could improve product quality or develop new products realizing allocative efficiencies (i.e., a different mixture of outputs is developed to improve revenues). Third, processors could reduce the cost of inputs through changes in ex vessel pricing to improve efficiencies. The change in overall efficiency of the sector would is the cumulative effect of changes in these different efficiencies. This section considers each of these contributions to overall efficiency in comparing processor efficiency under the different alternatives.

Effects of the status quo alternative on efficiency in the processing sector

In the current LLP fisheries, processing sector entry is not directly limited. Processors' participation decisions are economic. Processor technical efficiency, however, is limited by the competitive race for fish conducted by the harvest sector. In the largest fisheries, most processing occurs over the few days following the short season. A processor's ability to compete, however, is constrained by its ability to offload and process landings quickly. Since crab must be processed live, processors must work to ensure that harvests are offloaded quickly to minimize deadloss and maximize market share. Consequently, processors also participate in a race for fish, in which product recovery, development, and quality, and potential technical efficiencies and allocative efficiencies (in selecting the best mixture of non-crab inputs and crab product outputs) in production are sacrificed. If the current management is continued, these practices are likely to be maintained.

In the current fisheries, processors compete for landings with price and by offering goods and services to harvesters (such as fuel, bait, and pot storage). Harvesters, however, are challenged by the need to offload crab quickly to avoid deadloss, so harvester negotiating strength is limited. As noted earlier, harvesters have responded to this relative weakness by bargaining collectively. If the status quo is maintained, these practices are likely to continue.

Similar to the harvest sector, all processors will realize a loss of efficiency in times of low total harvests. Configuring crab lines and bringing in crews to work those lines for a limited supply of crab will reduce efficiency. As in the harvest sector, processors that are in the weakest financial position are likely to suffer the most at these times. Low plant throughput and product revenues could force some processors out of the fishery. In addition, processors that rely primarily on the crab fisheries (without stable participation in other fisheries) are likely to suffer greater efficiency losses. These processors are likely to have greater input costs, particularly if plants are opened and crews hired and transported to remote plants strictly for a brief period of crab processing.

Although some changes are likely as the fisheries evolve, processor efficiency under continuation of the current management is likely to remain relatively close to its current level.

Effects of the individual fishing quota alternative on efficiency in the processing sector

Under the IFQ alternative, seasons will be extended, ending the race for fish (Table 4.6-2). Processors will no longer be under pressure to process all landings in a few days at the end of a season, but will instead process landings that are distributed over the longer season. The distribution over a longer period of time creates an opportunity for improvements in technical efficiency and efficiencies in choices of outputs, if processors are able to coordinate deliveries, schedule crews and, allot facilities. Processing costs may be reduced and product recovery, quality, and returns may be increased. In addition, costs of maintaining inventories could be reduced if harvests can be timed to serve particular market demands, although this savings is likely to be minimal. The success of processors in realizing these gains depends on their ability to schedule deliveries from harvesters so that crew and facilities are neither idle nor forced to work at an excessive pace because of several simultaneous deliveries. While the timing cannot be expected to be precise, spreading deliveries over an extended period or having several vessels attempt to deliver at once could lead to a loss of efficiency.[18]

[18] The possibility of landings distributed over a long period of time is more likely than too many harvesters attempting to deliver at once, since harvesters will be free to deliver to another processor, to avoid an excessive wait to offload.

Whether processors would be able to schedule deliveries of crab to minimize efficiency losses cannot be known with certainty and may vary over time. Since harvesters will hold harvest shares with no obligation to deliver to any particular processor, processors would be forced to compete for landings with ex-vessel price and provision of goods and services. The ability of a processor to pay for landings will depend in part on processing production efficiencies (such as technical efficiencies and revenues from products). Harvesters that do not coordinate deliveries with processors may receive less for their landings (either in price or goods and services). In the long run, harvesters should perceive the benefits of coordinating deliveries to achieve technical efficiencies in processing. Periodic changes in delivery patterns, as harvesters shift from one processor to another, that cause some loss of technical efficiency in processing may persist. The cost of these inefficiencies could be small and cannot be predicted.

The regional delivery requirements of this alternative could result in some loss of technical efficiency, if processing that would consolidate in one region to realize efficiencies is required to be maintained in another region. The amount of inefficiency that would arise from the regional landing requirements cannot be predicted.

Although processors' negotiating leverage is reduced by the harvest share allocation under this alternative, the processors may still receive some of the rents of the crab resource. Entry to the processing sector could be limited to some degree by operational complexities allowing processors to receive some return in excess of normal profits. Regional landing requirements under this alternative could provide some additional leverage to some processors, if one region has less competition because of greater operational challenges. The extent of these affects on processing competition cannot be estimated.

Some processors might respond to the loss of negotiating leverage and the potential disruption of delivery patterns by vertically integrating. As noted earlier, vertical integration can help stabilize supplies of crab to a processor and provide information concerning harvesting operations and costs that can be used in negotiations with independent harvesters. The extent of this practice cannot be predicted and likely depends on the degree to which processors are successful in price negotiations and scheduling deliveries from independent harvesters.

During transitions, most importantly on implementation of the program, processing efficiency could decline substantially as processors compete to protect market share. Processors can typically be expected to receive normal profits and some portion of the resource rent. During these times of transition, it is possible that competition for ex vessel landings could lead processor to bid away even normal profits with some processors unable to compete being forced to drop out of the fishery altogether. Processors that are primarily crab processors are most likely to suffer efficiency losses on implementation, particularly if harvesters are unwilling to work to schedule deliveries. These processors could have substantial investments in transporting crews to their plants, housing and boarding those crews and have little crab processing for extended periods of time. Processors that are financially weak are also likely to suffer because of relatively intense competition as the fishery transitions between management programs.

Processor efficiency is also likely to be relatively low in periods of low total harvests. As at implementation, processors that are relatively weak financially or are primarily crab processors are also most likely to suffer as a result of the more intense price competition would likely occur because of the relative abundance of processing capacity.

The effects of this alternative on overall processing efficiency are difficult to predict. Harvesters are likely to gain substantial negotiating leverage from the allocation of harvest shares. Complexity of operations in the

Bering Sea that are likely to limit entry to the sector, but the extent of negotiating leverage provided by that barrier to entry cannot be predicted and is likely to change over time as circumstances in the fisheries change. The potential benefits to harvesters from working with processors is likely to limit the technical efficiency losses in processing that would result from poorly coordinated deliveries. The benefits of these operational efficiencies are likely to be shared by the sectors. Overall processing efficiency is likely be maintained or improve in the long run. During transitions, however, processing efficiency could decline as a result of losses in technical efficiency and intense ex vessel price competition.

Effects of the three-pie voluntary cooperative alternative on efficiency in the processing sector

Under the three-pie voluntary cooperative alternative, processing practices are likely to change substantially, with improvements in processing efficiency (Table 4.6-2). The allocation of harvest shares under this alternative will slow fishing substantially reducing the incentive for processors to quickly offload and process crab to avoid deadloss. Processors that are initially issued processing shares will be guaranteed access to 90 percent of the crab resource. These processing share allocations will provide processors receiving those allocations with substantial leverage for scheduling landings to avoid conflicts with other fisheries and minimize idle time for crews, which could result from poorly scheduled deliveries during the lengthened seasons. Additional time should also allow processors to increase revenues by improving product recovery and quality and to developing higher value products. Some processing technical efficiencies could be lost to accommodate harvester preferences, if processors are able to reduce ex-vessel prices by accommodating harvesters. These costs, however, would increase processor efficiencies on the whole, if the processor recovers the added cost by reducing ex vessel prices.

Processing sector efficiencies under this alternative are likely to be reduced by the regionalization and community protection program. The regionalization program could limit the ability of processors to consolidate processing geographically in areas that reduce processing costs. The impacts of the regional processing requirements are mitigated since only two regions are created in any fishery. The impacts, however, are long lasting, since the regional processing requirements are a permanent part of the program. The community protection measures that are likely to have the greatest impact on processor efficiency are the "cooling off period" and the right of first refusal. The cooling off period requires processors to process crab in the community in which processing occurred on which the processing share allocation is based. The effects of this provision on efficiency are limited since it would only apply in the first two years of the program. The efficiency reductions, however, could be substantial if a processor could be required to process small amounts of crab in remote locations. The impacts of the "cooling off provision" are difficult to characterize because the effects are likely to be dependent on harvest levels during the time the provision is applicable. In addition, no quantitative estimates of the impacts of the provision can be provided because data are unavailable.

The right of first refusal would grant CDQ and community groups a right of first refusal on shares being sold by a processor for processing outside of the community. In general, a provision of this type might be expected to reduce efficiency gains in the processing sector, by permitting community and CDQ groups to intervene in transactions that have potential to increase efficiencies. The effects of the provision cannot be predicted since the propensity of groups to exercise the right cannot be predicted. In the long run, the provision could deter efficiency increasing transactions that might occur through the movement of processing. The provision, however, has several exceptions that allow processors to move shares (both temporarily and permanently) that can be expected to limit its effects on efficiency.

The presence of 10 percent B shares, that have no regional, community, or processor share delivery requirements might slightly reduce processing efficiency. In most cases these shares are likely to be harvested simultaneously with A shares. In general, B share deliveries are expected to migrate to the most efficient processors. B share landings, however, may not migrate to efficient processors if harvesters can use those shares to leverage a better price for A share landings. The cap on IPQ in years of high total harvests in the Bristol Bay red king crab and Bering Sea *C. opilio* fisheries could also affect processor efficiency gains by allowing harvesters to determine deliveries based on the highest price (which should be a reflection of processor technical efficiencies and output decisions). Price concessions for these landings, however, could reduce overall processor efficiency. The continuation of the regional landing requirements on shares issued in excess of the IPQ cap could also limit overall processing efficiencies to some degree because of their effect on technical efficiencies.

During transitions, particularly on implementation and in years of low total harvests, processor efficiency will be relatively low. On implementation, relationships could be slow to develop resulting in relatively low processing efficiency, in comparison to later periods under the program. Share matching in the first few years could result in substantial inefficiencies if participants are reluctant to lease shares to others to achieve efficiencies while complying with the one-to-one match required of A shares and processing shares. Regional and community landing requirements will compound the coordination problem, since they require a relatively wide geographical distribution of landings. The structure of the arbitration program, which creates an incentive for matching shares and settling prices before or early in the season, should help overcome this potential loss of efficiency.

Processor efficiency is likely to be relatively low in times when total harvests are low because of scale effects and the regional and community landing requirements and community protections. The relatively small B share allocation will provide less leverage to harvesters during these periods. Processors that are financially weak, have relatively small allocations, or depend primarily on crab will be most vulnerable during these downturns. Processor share holdings will provide significant protection to these processors, but the financially weakest participants could be forced to exit. Divestiture of shares will provide some compensation to those that exit.

Processing efficiency, on the whole, should improve under this alternative, in comparison to the status quo. Slowing the race for fish and the pace of crab though plants will provide for processing technical efficiencies, as well as allocative efficiencies in the choice of outputs. The processor share allocation will provide allocation processors with significant negotiating leverage. To some extent, regional and community protections will reduce efficiencies, but overall efficiency should rise under this alternative.

Effects of the cooperative alternative on efficiency in the processing sector

As under the other two rationalization alternatives, the slowing of fishing under the cooperative alternative will provide the processing sector with the opportunity for improved efficiency through increased revenues and reduced costs (Table 4.6-2). The realization of that opportunity will depend, in part, on the ability of processors to coordinate deliveries to realize technical efficiencies and allocative output efficiencies (i.e., a better choice of outputs because of less time constraint on processing). The cooperative structure of this alternative will affect processors realization of those efficiencies. Since processors associated with a cooperative will receive 90 percent of the cooperative's landings, the coordination of those deliveries should be simplified both through the landing requirement and the cooperative structure of the alternative. As a result, processors should be able to achieve coordination under this alternative for those annual landings (i.e., 90 percent of the total harvest allocation. Since ex vessel price depends entirely on the negotiated price (without the protection of arbitration) coordination of these deliveries is likely to be comparable or exceed the level of coordination of deliveries under the other rationalization alternatives. This coordination should result in relatively high technical efficiencies and allocative efficiencies in outputs for the processor receiving these deliveries. Other aspects of this alternative, however, will also influence efficiency in the processing sector under this alternative.

Since processors must compete for the 10 percent of each cooperative's deliveries, the distribution of those landings among processors will depend on the willingness of the processors to pay for those deliveries. Since overall (harvesting and processing) efficiency are likely to be a large factor in the competition for deliveries that are not designated for the cooperative's associated processor, processor technical efficiencies and output allocative efficiencies should also be realized on those deliveries.[19]

Across processors, however, technical and allocative output efficiency could be decreased by the rule that a harvester would forfeit 10 percent of its annual allocation for one year for changing cooperatives without consent of the associated processor. For example, a harvester may choose not to change cooperatives even though the move would result in greater processing technical and allocative output efficiency (and a higher ex-vessel price for the harvester) because the 10 percent forfeiture might not be recouped for a few years.[20] Uncertainty concerning the total harvests in the fisheries could affect these decisions in some cases. Overall efficiency in the processing sector could be diminished by the forfeiture, if inefficient processors remain in the industry that would be forced out by competition. The ability of processors to sell their interests, including any cooperative associations, could overcome this loss of efficiency, if less efficient processors are willing to sell their interests to more efficient processors. In addition, unanticipated moves among processors could decrease technical efficiency in some instances.

Processor efficiency will also be affected by ex vessel prices, which in turn, will be affected by the allocation of harvest shares and the structure of the cooperative alternative. Slowing the race for fish will provide harvesters with negotiating leverage, which is countered by the requirement that a cooperative deliver 90 percent of its catch to its associated processor. The commitment of deliveries by these associations is likely to limit entry to the processing sector and reduce competition among processors overall. Harvesters are allowed to change associations by forfeiting 10 percent of their annual allocation, limiting the extent to which a processor can exert negotiating leverage from the landing requirement. Transitions, such as low total harvests, could affect the decisions to change associations by harvests. A harvester might be more likely to move in a year of low total harvests since the forfeiture will be a small share of total harvest. On the other hand, the loss of revenues from the forfeiture could be more significant to the harvester in years of low total harvest because total revenues of the harvester will likely be less.

The ability of cooperatives to deliver 10 percent of their landings to any processor will reduce processor efficiency (through a reduction in ex vessel price) for those landings. Even if the associated processor receives these landings for the same price as all other landings from the cooperative, the overall effect of these shares will be a reduction in processor efficiency, because the cooperative will have used the shares to obtain a higher price for all landings.

[19] A cooperative could accept a lower ex-vessel price for its 10 percent open delivery shares, if it could improve harvest efficiencies or leverage a better price on deliveries of A share crab to its associated processor. So, it is possible that the most efficient processor will not receive all landings of open delivery share harvests.

[20] Large harvest level changes could be addressed through custom processing arrangements, under which a cooperative might deliver to a processor other than its associated processor. These arrangements could occur only with the consent of both the cooperative and its associated processor. That consent should be received, if substantial efficiencies could be realized and shared by all.

The year before implementation, processors are likely to compete aggressively for landings, since harvester associations are based on landings in that year. During that year, processors are likely to bid away rents, and perhaps some profits, if they believe that they will be able to recoup those expenditures in later years. Processor competition will be limited somewhat since the ability of processors to realize a long run benefit from the association will be limited since harvesters can leave a cooperative unilaterally subject to the 10 percent forfeiture. The overall effect of this alternative on prices, however, is difficult to predict

Transitions, particularly reductions in total harvests, are likely to reduce efficiencies in the processing sector. The extent of these reductions is hard to predict and likely depends on the circumstances of participants in the both sectors and the extent to which participants are willing to coordinate activities both within and across cooperatives. As under all of the alternatives, processors that are the weakest financially and those that depend primarily on the crab fisheries are the most vulnerable at these times.

Overall, this alternative is likely to improve on (or at worst maintain) processing sector efficiency in comparison to the status quo alternative. Processor protections will limit ex vessel price competition that could arise in a fishery with harvest share allocations. The slowing of the race for fish and the ability of processors to use the cooperative associations and cooperative landing requirements to coordinate landings will contribute to improvements in technical efficiency and output development . Although the impact of the alternative on ex vessel prices is uncertain, gains in technical efficiency in processing and gains from product improvements will ensure that processor efficiency improves from the status quo.

4.6.2.3 Efficiency in the production of the fisheries overall (harvesting and processing)

Overall efficiency in production is equivalent to the sum of efficiency in harvesting and efficiency in processing. This section summarizes the effects of the alternatives on production in the fisheries overall deriving most of its findings from the above analysis. In large part, overall efficiency will depend on the ability of industry to base its decisions on the markets it serves and the markets that it draws inputs from. Regulatory measures that limit the ability of industry to respond to market incentives will reduce overall production efficiency.

Effects of the status quo alternative on production efficiency (harvesting and processing)

Under the status quo alternative the current race for fish will be perpetuated. Efficiency will continue to be compromised by compressing harvesting in processing into a relatively short time period. Both harvesters and processor will use more inputs than would be used in a slower fishery. Product recovery, quality, and development will be sacrificed as participants race to protect market share. Overall efficiency in the fisheries should remain at its current level.

Effects of the individual fishing quota alternative on production efficiency (harvesting and processing)

Production efficiencies in the fisheries, as a whole (harvesting and processing), will increase under the IFQ alternative as a result of the allocation of harvest shares, which end the race for fish. Both sectors should realize gains in technical efficiencies as inputs are reduced and outputs are increased. Product quality and product developments should also add to gains in overall efficiency. In general, the extent of gains under any of the rationalization alternatives will depend on the ability of industry to coordinate its activities within and across sectors and respond to markets without regulatory limits on activities. Regional landing requirements limit harvester ex vessel markets. The absence of community protections under this alternative should add to overall production efficiency. Although the absence of a structure that would guide the relationship between the sectors (i.e., processing share or landing requirements) will allow harvesters to respond to market signals, the absence of these structures could add transaction costs to efforts to coordinate activities within and across the sectors. Overall production efficiency should be greater under this alternative than under the status quo alternative.

Effects of the three-pie voluntary cooperative alternative on production efficiency (harvesting and processing)

Production efficiencies will also increase under the three-pie voluntary cooperative alternative as a result of the allocation of harvest shares, which end the race for fish. Technical efficiencies and improvements in product recovery and quality and product developments are the prime components of these gains in overall efficiency. The cooperative structure of this alternative could improve coordination, if harvesters elect to use that voluntary structure. Processor shares could improve coordination of activities across sectors. Processor shares, however, limit the ability of harvesters to respond to markets, which could limit efficiency gains. The arbitration program could counter this effect, provided the arbitrator is able to understand efficiency implications of the different circumstances of participants in the fishery. This effect is likely regardless whether many participants engage in arbitration since the expected arbitration outcome will impact negotiated prices. Community protections and regional landing requirements also will limit production efficiency gains under this alternative. Overall production efficiency, however, should be greater under this alternative than under the status quo alternative.

Effects of the cooperative alternative on production efficiency (harvesting and processing)

As under the other two rationalization alternatives, production efficiency will improve under the cooperative alternative through improvements in technical efficiency, product recovery and quality and product developments. Coordination in and across sectors will be improved by the cooperative structure, but could be decreased by the rule governing movement across cooperatives. Production efficiency gains could also be reduced because of the cooperative/processor associations decline because of the limitation on harvester ability to respond to changes in the ex vessel market. Production efficiency should improve over the status quo under this alternative.

Table 4.6-6 Processor efficiency under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Processor efficiency - revenues less costs	Processor efficiency remains at current level - efficiency is sacrificed by time pressures on processing resulting from the race for fish.	1) Processor efficiency improves with end of the race for fish. 2) Efficiency at the processing entity level may be increased by ability of processors to coordinate deliveries using leverage of processor shares. 3) Arbitration effects ex vessel prices. 4) Landing requirements and community protections may reduce efficiency (industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss).	1) Processor efficiency improves with the end of the race for fish. 2) Processors compete for landings with ex vessel price. 3) Efficiency may be reduced by regional landing requirements.	1) Processor efficiency improves with end of the race for fish. 2) Efficiency at the processing entity level will be increased by cooperative processor landing requirements. 3) Efficiency across processors could be reduced by share forfeiture rule for changing cooperatives (industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss).

Table 4.6-6 (cont.) Production efficiency under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Production efficiency (harvesting and processing)	Efficiency remains at current level - efficiency is sacrificed by time pressures resulting from the race for fish.	1) Efficiency improves with end of the race for fish. 2) Coordination may increased by voluntary cooperatives 3) Processing shares allow processors to coordinate deliveries but limit harvesters' ability to respond to market 3) Arbitration effects may mitigate some loss of efficiency from processor share market restriction 4) Regional and community landing requirements and community protections may reduce efficiency	1) Efficiency improves with end of the race for fish. 2) Regional landing requirements could limit ex vessel market decisions. 3) Transaction costs in markets could reduce overall efficiency.	1) Efficiency improves with end of the race for fish. 2) Coordination may increased by cooperative structure. 3) Cooperative landing requirements will limit efficiency gains.

4.6.3 Captains and crew

Effects of the status quo alternative on captains and crew

In the current fishery, captains and crew are typically compensated through crew shares, under which each crew member receives a portion of the gross revenues of the vessel's harvests (Table 4.6-7). In recent years, the intensity of the race for fish combined with stock declines have reduced average crew compensation considerably. The short seasons have limited crews that participate in the major crab fisheries to only a few weeks of fishing. Although most of the crab fisheries are not open year-round, many captains and crew relied on the fisheries as a sole or primary source of income in the past. The low total harvests and high competition in recent fisheries have limited the ability of captains and crew to rely on crab fisheries as a sole source of income.

If current management of the fisheries continues, the number of vessels participating in the fisheries could decline unless stocks recover. Notwithstanding any decline in participation, the intense, competitive seasons are likely to continue. As a result, captains and crew are likely to continue to be faced by a very competitive industry, in which many will supplement their income from the crab fisheries with income from other sources.

Effects of the IFQ alternative on captains and crew

The IFQ alternative will affect captains and crew in a few ways. An expected decrease in the number of vessels in the fleet will decrease the number of captains and crew (Table 4.6-7). This change, as well as the general slowing of the fishery, could affect the bargaining power of captains and crew relative to vessel owners. Although the removal of vessels will reduce the number of participating captains and crew, remaining participants are likely to be active for substantially longer periods of time than in the current fisheries. Changes in compensation of remaining captains and crew is difficult to predict. Competition for jobs could lead to decreased compensation, at least at the outset. Anecdotal evidence from some rationalized fisheries is that some captains and crew no longer receive crew shares, but are compensated with wages, which could be less lucrative. In addition, anecdotal evidence from some rationalized fisheries suggests that some vessel owners may remove QS royalty fees from ex vessel revenues prior to determining captain and crew shares. In some evidence suggests that vessel owners have charged these fees on both purchased QS and QS received in the initial allocation. If these royalties are charged prior to determining captain and crew shares, captain and crew could suffer a reduction in revenues.

The allocation of 3 percent of the TAC as C shares for use by captains and crew could mitigate potential negative effects of the transition to an IFQ fishery. Whether or not holders of these shares will be able to leverage better compensation with the relatively small allocation cannot be predicted. In addition, the initial allocation of these shares to captains only could limit their effectiveness in protecting crew at the outset. Since these C shares require the owner to be on board the vessel fishing the shares, they should trade at a lower price. This lower price, together with the crew loan program, could enable more crew to develop a long-term interest in the fishery that can be used to protect their interests.

Although less crew are likely to be employed in a rationalized fishery, the professionalism of crews could rise under the IFQ alternative. Since crews will be active for a longer time, crews should gain greater experience and have less time reorienting themselves each season. Fewer inexperienced crewmembers will participate in the fisheries and turnover should be limited, if crew are compensated at a level they deem appropriate.

Effects of the three-pie voluntary cooperative alternative on captains and crew

The effects of the three-pie voluntary cooperative alternative on captains and crew should be very similar to the effects of the IFQ alternative (Table 4.6-7). The longer seasons together with the decline in the number of vessels should result in the fewer crew positions that employ crew for a longer time-period each year. Captain and crew compensation could change, if competition increases for the remaining jobs. If royalties are charged for QS holdings, captain and crew shares would suffer. The C share program should provide some mitigation to captains affected by the program, but the relatively small allocation of C shares is likely to have very limited effects as a result of the restrictions placed on those shares. Since these C shares require the owner to be on board the vessel fishing the shares, they should trade at a lower price. Whether holders of these shares will be able to leverage better compensation with the relatively small allocation cannot be predicted, but is not likely. The ability of holders of C shares to use those shares for negotiating leverage will be limited by the requirement that those shares be subject to the 90/10 A share/B share division in the third year of the program. Since C share holder allocations will require landing of the shares with the holder of processor shares, the captain will need to displace not only another captain but also a harvest share holder in order to move into a new position. The need for such a displacement limits the use of C shares as negotiating leverage since the threat of a C share holder to walk away from a position is dependent on the existence of another position on a vessel that delivers to a processor with uncommitted processing shares. So, C shares provide their holders with an allocation of little value for negotiation but which can be divested when leaving a fishery or moving between positions. Given the minor importance of these shares relative to the general harvest share allocation, holders of general harvest shares and processing shares are unlikely to respond to these shares in a market that requires the matching of C shares with processing shares.

Although less crew are likely to be employed in a rationalized fishery, the professionalism of crews could rise under this alternative. Since crews will be active for a longer time, crews should gain greater experience and have less time reorienting themselves each season. Fewer inexperienced crewmembers will participate in the fisheries and turnover should be limited, if crew are compensated at a level that instills long term participation.

Effects of the cooperative alternative on captains and crew

Captains and crew are likely to be affected by the cooperative alternative similar to the two other rationalization alternatives (Table 4.6-7). Fewer crew will be employed on fewer vessels, however, they will be employed for a longer time-period each season. Compensation of crew cannot be determined, but will be affected by competition for jobs and the C share program.

Table 4.6-7 Effects of alternatives on captains and crew.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Effects on captains and crew	1) Short seasons limit earning abilities of captains and crew. 2) Crew shares provide participants with a portion of vessel revenues.	1) Extended seasons with fewer vessels provide steady employment to fewer crew. 2) Competition for jobs could reduce compensation or result in change to wage system for some crew. 3) C shares could have effect on negotiating leverage of holders, but this is severely diminished by processor share landing requirement after three years.	1) Extended seasons with fewer vessels provide steady employment to fewer crew. 2) Competition for jobs could reduce compensation or result in change to wage system for some crew. 3) C shares should provide some negotiating leverage to holders.	1) Extended seasons with fewer vessels provide steady employment to fewer crew. 2) Competition for jobs could reduce compensation or result in change to wage system for some crew. 3) C shares should provide some negotiating leverage to holders.

4.6.4 Excessive shares, other fisheries, consumers, and environmental benefits

4.6.4.1 Excessive shares in the fisheries

The Magnuson-Stevens Act requires that any IFQ program prevent a person from acquiring an excessive share of issued quotas; no specific guidance concerning appropriate limits on consolidation is provided. Limits on excessive share holdings are intended to limit concentration of market power, provide opportunity for entry, provide competition in the labor market, and ensure that the resource supports a reasonable number of participants. This section analyzes the potential for excessive share holdings under the different alternatives under consideration.

Effects of the status quo alternative on the acquisition of excessive shares in the fisheries

The current LLP management of the BSAI crab fisheries does not allocate shares of the fishery to any participants. Consequently, a required limit on acquisition of an excessive share is inapplicable to this alternative.

Effects of the three-pie voluntary cooperative alternative on the acquisition of excessive shares in the fisheries

The three-pie voluntary cooperative alternative would allocate harvest shares to harvesters and processing shares to processors. Table 4.6-8 shows the harvest share limits for individuals, CDQ groups, and vessels in each fishery.

Table 4.6-8 Harvest limits.

Fishery	Limit on percent of harvest share pool a person may hold	Limit on percent of harvest share pool a CDQ group may hold	Limit on percent of harvest share pool a vessel may use
Bristol Bay red king crab	1	5	2
Bering Sea *C. opilio* (snow crab)	1	5	2
Bering Sea *C. bairdi* (Tanner crab)	1	5	2
Western Aleutian Islands (Adak) golden king crab	10	20	20
Eastern Aleutian Islands (Dutch Harbor) golden king crab	10	20	20
Western Aleutian Islands (Adak) red king crab west of 179˚ W	10	20	20
Pribilof Islands blue and red king crab	2	10	4
St. Matthew blue king crab	2	10	4

Notes: CDQ - community development quota

Limits on share holdings and use vary inversely with the size and value of the various fisheries. In addition, the caps were developed in consideration of historical participation levels. In the Bristol Bay red king crab, Bering Sea *C. opilio*, and Bering Sea *C. bairdi* fisheries, the limit is approximately equal to the largest initial allocations. In the St. Matthew blue king crab fishery, the cap is approximately 1 percent less than the initial largest allocation and approximately 12 of 138 allocations will be in excess of the cap. In the Pribilof Islands red and blue king crab fisheries, the cap is slightly larger than the largest allocations in the fishery. In the Aleutian Islands fisheries, the largest allocations are substantially larger than the caps.

A few exceptions to caps are worthy of discussion. First, initial allocations in excess of the caps are exempt from the caps. In most fisheries, this exception is insignificant. However, in the Aleutian Islands crab fisheries, the exemption to these caps for initial allocations will lead to substantial consolidation in excess of the cap at the outset of the program. In the western Aleutian Islands (Adak) golden king crab fishery, the average of the four highest allocations is more than double the 20 percent ownership cap. These four largest allocations total approximately 90 percent of the entire allocation in the fishery. Similarly, in the western Aleutian Islands (Adak) red king crab fishery, the four leading allocations average almost 20 percent of the harvest share pool. In the eastern Aleutian Islands (Dutch Harbor) golden king crab fishery, the four highest allocations are approximately 16 percent of the harvest share pool. Although purchases of shares could not exceed the caps, the exemption of the initial allocation in these fisheries will result in substantial consolidation in excess of the cap at the outset of the program. Since the initial allocation is based on historic participation, some participants could argue that these allocations in excess of the cap are appropriate because they preserve historic practices in these fisheries.

A second exception to the limitations on holdings and use of shares is the exemption of cooperatives from vessel use caps. This exemption could result in the consolidation of shares on vessels by cooperatives in excess of the caps, particularly in years of low total harvests.

Beyond the exceptions, the relatively high limits on share holdings of CDQ groups could allow for substantial consolidation of shares by these groups. Since CDQ groups represent communities and their residents, these higher caps can be justified as a means to permit more representative share holdings by these entities.

The consequences of these caps on market power, the labor market for captains and crew, and entry is likely to be limited. In other words, the impacts of this alternative on distribution of benefits described in Section 4.6.2 are likely to be unaffected by the concentration of harvest shares at the levels permitted by the caps. Similarly, the concentration of shares is unlikely to affect the impacts of the alternative on captains and crew beyond that described in Section 4.6.8. The impacts of concentration of shares as permitted by this alternative on entry are likely to be as described in Section 4.6.6.

The allocation of processing shares in the different fisheries under this alternative also requires that consolidation of share holdings in that sector be considered. Processing share holdings are limited to 30 percent in each fishery. In addition, a separate provision would prohibit any processor from holding more than 60 percent of north region shares in the Bering Sea *C. opilio* fishery. These limits ensure that at least four processors must hold processing shares in each fishery. The absence of regional share holding limits in most fisheries, however, could result in one or two processing share holders per region in several instances. The import of concentration of processing share holdings varies depending on the issue of concern.

Although competition in the processing labor market could be argued to be limited by concentration at the level permitted by these caps, the effects of concentration of crab processing are likely limited by the current level of concentration in processing and the processing activity in other fisheries. Crab processing could be an important part of a processor's activities, but limiting holdings to 30 percent in each of these fisheries is likely to prevent any processor from controlling the processing labor market. In addition, the diversity of processing activity by most participants and the activity of processors in groundfish could limit the consequences of the concentration of processing at the level permitted by the caps.

The effects of this alternative on the distribution of benefits between the harvesting and processing sector are discussed in Section 4.6.2. Concentration of processing shares could impact that distribution of benefits if processing shares are held exclusively by processors that do not pursue the best market opportunities. The allocation of 10 percent of the fishery to harvesters without processing share delivery requirements, however, provides harvesters with the ability to demonstrate that processors are not pursuing marketing opportunities by developing those opportunities with processors not holding processing shares. Information concerning market opportunities could then be used in arbitration to justify increases in ex-vessel prices. The relatively small share of the fisheries allocated without processing share delivery requirements could limit the ability of harvesters to develop these opportunities, if processor shares are concentrated to the maximum extent permitted.

Effects of the individual fishing quota alternative on the acquisition of excessive shares in the fisheries

Limits on excessive shares on the harvest sector under this alternative are the same as those under the three-pie voluntary cooperative alternative. Likewise, consolidation at the levels permitted by under this alternative will not change the conclusions concerning the distribution of benefits between harvesters and processors, captains and crew, and entry to the harvest sector (Sections 4.6.5, 4.6.8, and 4.6.6, respectively).

Since no processor shares are allocated under this alternative, excessive shares are not at issue.

Effects of the cooperative alternative on the acquisition of excessive shares in the fisheries

Limits on excessive shares on the harvest sector under this alternative are the same as those under the three-pie voluntary cooperative alternative. Likewise, consolidation at the levels permitted under this alternative will not change the conclusions concerning the distribution of benefits between harvesters and processors, captains and crew, and entry to the harvest sector (Sections 4.6.5, 4.6.8, and 4.6.6, respectively).

Since no processor shares are allocated under this alternative, excessive shares are not at issue (Table 4.6-9).

Table 4.6-9 Excessive shares under each alternative.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Excessive shares	1) No allocations to either sector, so no excessive share issue.	1) Limits on excessive shares in the harvest sector. 2) Limits on excessive shares in the processing sector.	1) Limits on excessive shares in the harvest sector. 2) No allocation to processing sector.	1) Limits on excessive shares in the harvest sector. 2) No allocation to processing sector.

4.6.4.2 Spillover effects on other fisheries

The rationalization of the crab fisheries and the slowing of the race for fish has the potential to free vessels from the crab fisheries for use in other fisheries. This section examines the potential spillover effects of the different alternatives on other fisheries (Table 4.6-10).

Table 4.6-10 Spillover effects of each alternative on other fisheries.

	Status quo	Three-pie voluntary cooperative	IFQ	Cooperative
Spillover effects on other fisheries	1) No influence on other fisheries except if seasons change.	1) Sideboards limits should prevent spillover effects on other federal fisheries. 2) Additional action by State or Council may be necessary to protect State crab and groundfish fisheries.	1) Sideboards limits should prevent spillover effects on other federal fisheries. 2) Additional action by State or Council may be necessary to protect State crab and groundfish fisheries.	1) Sideboards limits should prevent spillover effects on other federal fisheries. 2) Additional action by State or Council may be necessary to protect State crab and groundfish fisheries.

Notes: IFQ - individual fishing quota

Effects of the status quo alternative on other fisheries

The status quo alternative would maintain the race for fish in the crab fisheries. Other fisheries are unlikely to be affected by this alternative any differently than current management. Generally, the impacts of crab vessels on other fisheries is limited by their competition in the crab fisheries. In 2000, a delay in the Bering Sea *C. opilio* fishery created an opportunity for several vessels from that fishery to participate in the GOA cod fisheries. The experience in this year provides an indication of possible future influx of effort into the fishery should the Bering Sea *C. opilio* fishery be delayed again in the future. The current management would leave GOA groundfish fisheries unprotected from any such influx of effort.[1]

Effects of the three-pie voluntary cooperative alternative on other fisheries

The three-pie voluntary cooperative alternative would allocate harvest shares to participants in crab fisheries, ending the race for fish. The license requirements of the LLP limits the ability of harvesters to increase effort in other fisheries. Examination of the licenses held by the participants in the different crab fisheries shows that primarily spillovers are in the central and western GOA Pacific cod fisheries by vessels that participate in the Bering Sea *C. opilio* fishery. To limit any influx of effort from the crab fisheries, this alternative would limit harvesters to their historic harvests in all GOA fisheries. Vessels with minimal harvests in the Bering Sea *C. opilio* fishery and substantial harvests in the GOA Pacific cod fisheries would be exempt from these limitations, since these vessels have little dependence on the crab fisheries. In addition, vessels with less than a minimum historic harvest from GOA groundfish fisheries would not be permitted to participate in GOA groundfish fisheries. These limitations are likely to prevent any adverse spillover effects from an influx of effort from the crab fisheries to other federal fisheries under this alternative. State crab and groundfish fisheries, however, could be impacted in the absence of further action by the State or Council.

[6] In the event that GOA groundfish fisheries become rationalized, the ability of crab vessels to move into those fisheries would be limited by that rationalization program, removing any concern about spillover effects under any of the alternatives.

Effects of the IFQ alternative on other fisheries

The potential spillover effects on other fisheries under this alternative are the same as those under the three-pie voluntary cooperative alternative. In addition, limits on harvests by participants in the crab fisheries from GOA fisheries under the three-pie voluntary cooperative alternative are incorporated into this alternative. Consequently, the spillover effects on other fisheries under this alternative are the same as the spillover effects of the three-pie voluntary cooperative alternative.

Effects of the cooperative alternative on other fisheries

The potential spillover effects on other fisheries under this alternative are the same as those under the three-pie voluntary cooperative alternative. In addition, the limits on harvests by participants in the crab fisheries from GOA fisheries under the three-pie voluntary cooperative alternative are incorporated into this alternative. Consequently, the spillover effects on other fisheries under this alternative are the same as the spillover effects of the three-pie voluntary cooperative alternative.

4.6.4.3 Consumers

Effects of the status quo alternative on consumers

Under the LLP management, harvesters race for fish to capture market share (Table 4.6-11). Handling of undersized and female crab bycatch and ghost fishing by lost pots could contribute to some mortality. When fishing ends, harvesters line up at processing facilities, while processors engage in a similar race to quickly offload and process crab to gain market share and limit deadloss. The pace of processing limits the ability of processors to focus on product recovery and quality. If the current management is continued, these practices are likely to be continued.

Effects of the three-pie voluntary cooperative alternative on consumers

Improved product quality, increased variety of products, and increased product recovery are likely to benefit consumers as the race for fish removes time constraints on both harvesters and processors (Table 4.6-11). Greater emphasis on product quality and recovery is likely. In addition, to the extent that the change in management improves conditions of crab stocks, consumers are likely to benefit from additional product in the market. Some product development is likely to occur in a rationalized fishery. Absent the pressures of a race to fish, processors will have time to develop new products, and increase the variety of crab products in the market. Since Bering Sea crab is part of a world market, prices are not likely to be affected substantially by the program. Although processing shares are likely to give processors leverage in negotiations with harvesters, the cap on processing shares holdings is likely to be adequate to ensure that no processor gains control of the product market to the detriment of consumers. The magnitude of these benefits are unknown.

Table 4.6-11 Effects of alternatives on consumers.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Effects on consumers	1) Time constraints from short seasons limit industry's ability to improve quality and recovery, add value, and engage in product development.	1) Removal of time constraints allows industry to improve quality and recovery, add value, and engage in product development.	1) Removal of time constraints allows industry to improve quality and recovery, add value, and engage in product development.	1) Removal of time constraints allows industry to improve quality and recovery, add value, and engage in product development.

Effects of the individual fishing quota alternative on consumers

The effects of the IFQ alternative are likely to be similar to those of the three-pie voluntary cooperative alternative (Table 4.6-11). The removal of time pressures is likely to increase product recovery, quality, and lead to the development of new products. These effects are likely to benefit consumers, however, the magnitude of these benefits cannot be estimated.

Effects of the cooperative alternative on consumers

The cooperative alternative is likely to have similar consumer benefits as the other rationalization alternatives (Table 4.6-11). The end of the race for fish should provide industry with the opportunity to improve product recovery and quality and to develop new products. As under the other rationalization alternatives, the magnitude of these benefits cannot be estimated.

4.6.4.4 Environmental benefits

Improvements in environmental conditions are valued by the public at large. For example, preservation of endangered species is often considered to have significant value to the public. Although crab populations could be of less concern to the public than high visibility species such as bald eagles, it is likely that the public values preservation of these stocks. The value of knowing that a stock is well maintained in its natural habitat is commonly referred to as a non-use value. No known studies of the non-use value of crab stocks have been conducted to date, preventing any quantitative estimates of the value of stock preservation. This section, however, provides a qualitative analysis of the benefits the public is likely to receive from the existence of these stocks under the alternatives (Table 4.6-12).[2]

[2] This section intends to discuss only the public benefits from the environmental consequences of the alternatives.

Table 4.6-12 Environmental benefits of the alternatives.

	Alternative 1 Status quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Effects on environmental benefits	1) Race for fish reduces soak times and limits ability to precisely manage total harvests reducing environmental benefits.	1) Reduced time constraint results in longer soak times, reduction in lost gear, and reduced bycatch increasing environmental benefits. 2) Allocation of harvest shares allows more precise stock management increasing environmental benefits.	1) Reduced time constraint results in longer soak times, reduction in lost gear, and reduced bycatch increasing environmental benefits. 2) Allocation of harvest shares allows more precise stock management increasing environmental benefits.	1) Reduced time constraint results in longer soak times, reduction in lost gear, and reduced bycatch increasing environmental benefits. 2) Allocation of harvest shares allows more precise stock management increasing environmental benefits.

Effects of the status quo alternative on environmental benefits

Under current LLP management, harvests are managed using GHLs. Fishing managers monitor inseason fishing timing closures when the GHL is estimated as taken. Although managers have become very good at estimating total harvests, this method of controlling harvests is somewhat inaccurate and has occasionally resulted in harvests in excess of the GHL. For example, in the Bering Sea *C. opilio* fishery harvest exceeded the GHL in every year from 1995 to 2000.

The current management could also impact stocks through its affects on fishing practices. The race for fish has resulted in very short soak times as harvesters pull pots quickly in an attempt to maximize harvests. These short soak times leave pots little time to sort undersized and female crab, increasing handling and on-deck sorting, which contributes to crab mortality. The race for fish may also contribute to loss of pots as harvesters take less time to search for pots since it may result in leaving fish on the grounds. These lost pots could contribute to crab mortality by ghost fishing.[3] If current management is continued, these environmental impacts can also be expected to continue.

[3] Ghost fishing is a term used to describe pots that are lost, but still in a condition to continue catching crab and other fish. The crab become trapped in the pots and die effectively rebaiting the trap. Depending on how long it takes for the twine on the escape mechanism in a pot to decompose, a lost pot may continue ghost fishing for several months.

Effects of the three-pie voluntary cooperative alternative on environmental benefits

All three of the rationalization alternatives are likely to contribute environmental benefits from both improved fishing practices and improved management of stocks. Changes in the fisheries under rationalization and their effects on stocks, however, cannot be fully predicted. Increased soak times are anticipated in a rationalized fishery. These increases could lead to improved sorting of harvests by gear reducing the amount and handling of discards in the fishery. A reduction of discards is likely to reduce mortality to the benefit of stocks. If fishers are able to fish with greater care in a rationalized fishery, they also may be able to reduce the number of pots that are lost each year.

Additional benefits could also arise from other effects of rationalization. Improving the timing of deliveries to processors may reduce line-up times, which can be as high as 36 hours in some of the current fisheries. Reducing the amount of time crab spend in a vessel's tanks should decrease the number of crab that die during the wait to offload. Since crab must be processed live, crab that die in the tank (deadloss) have no market value. If deadloss were to be decreased it would reduce the amount of crab harvested that is not utilized.[4]

In a rationalized fishery, catch is likely to be managed more precisely than in the current competitive fishery. In the competitive fishery, harvests are monitored through voluntary inseason reports from participants. In a rationalized fishery, with no permitted overages or underages, overharvests could be minimized because the catch of each vessel is strictly limited by share holdings.[5] Penalties will be instituted to ensure limits are not exceeded.

A competing effect could arise if harvesters perceive a benefit to high grading. High grading is likely to occur if the increase in revenues from discarding low value, barnacled, or brown shell crab and harvesting high value, clean shell crab exceeds the increase in cost of making those discards and harvests. To the extent that efforts of the harvest sector to increase quality of catch increase discard mortality, these efforts could reduce the net benefits derived from the fishery in the long run. Harm to stocks from high grading could decrease future harvests and total revenues realized from the fishery. Issuance of fixed harvest allocations that extend several years into the future are argued by some to reduce the incentive for detrimental high grading, if fishers perceive a future cost to high grading. The extent and effects of any high grading problem cannot be predicted. Both harvest strategy modifications and improved monitoring could be used to mitigate the effects of high grading.

Improvements in the precision of crab fisheries management should result in an increase in net benefits under rationalization. Although certain incentives in a rationalized fishery could result in environmentally harmful fishing practices, careful monitoring can be used to minimize harmful practices. With a well tailored monitoring program, rationalization could lead to improved environmental conditions and an increase in the net benefits to the environment.

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[4] Reductions in deadloss would also increase the net benefits for harvesters since deadloss would be counted against the IFQ holder's allocation.

5 Underharvesting, which is likely to occur in a rationalized fishery, can be limited by liberal share transfer rights.

Effects of the IFQ alternative on environmental benefits

The effects of the IFQ alternative on environmental benefits are the same as those under the three-pie voluntary cooperative alternative. More precise management under a TAC could benefit stocks provided high grading does not increase to the detriment of stocks. Decreased ghost fishing of lost gear and better sorting of gear with longer soak times should also reduce crab mortality. A well managed monitoring program is important to ensure that these benefits are achieved.

Effects of the cooperative alternative on environmental benefits

The cooperative alternative structure can be expected to have the same effects on environmental benefits as the other two rationalization alternatives. Assuming that a rigorous monitoring program is included in the program, stocks should be more precisely managed and crab mortality should be reduced under the cooperative alternative.

4.6.5 Community/social effects of the alternatives

As described in Section 3.4.4, the community and social impact assessment in this EIS utilizes a two-pronged approach to understanding the nature, intensity, and differential distribution of potential impacts. Community and social impacts are discussed in this section and in an appendix to this volume (Appendix 3: Social Impact Assessment, BSAI Crab Fisheries FMP EIS, Overview and Community Profiles). These two discussions, taken together, comprise the Social Impact Assessment (SIA) for crab rationalization.

In this section, impacts are described based on output projections using the quantitative fisheries data sources for harvesting and processing presented in Section 3.4.4 as a baseline, where those data can meaningfully be attributed to communities or regions. As discussed in Section 3.4.4, there are fundamental problems with sector-based community discussions for a number of the sectors, based upon data confidentiality considerations. This is less problematic for data associated with the more numerous harvest vessels than for the analysis of processor related data. Within the constraints imposed by the data, this section focuses on quantitative data and contains a series of discussions and tables that cover potential impacts related to changes in the harvest vessel (CV plus C/P), C/P, and processing (shore plant, floater) sectors associated with each of the alternatives.

Appendix 3 focuses more on narrative descriptions supplemented with quantitative and qualitative data to analyze potential community and social impacts. The community profiles in the appendix each contain an analysis of the nature, direction, and magnitude of the social impacts likely to result from the proposed alternatives. Appendix 3 also contains a specific overview of community experience with previous fishery rationalization programs and provides a summary of community level impacts of those programs likely to be useful as analogs for anticipating impacts associated with the proposed rationalization alternatives. The appendix features a discussion of CDQ region impacts to supplement the summary discussion in Section 4.6.8.

Additional information on social impacts specific to minority populations and low-income populations may be found in Section 4.7. This information is presented at both the community and sector levels, supplementing the information contained in this section.

4.6.5.1 Community/social impacts: Harvest sector

Status quo alternative

Under the status quo alternative, the fishery would continue in a manner similar to that seen under existing conditions. Impacts similar to those associated with overcapitalization and the race for fish seen in the fishery at present would continue. That is, the status quo alternative would not result in a static or stable situation. Current problematic dynamics would continue, and adverse sector and community or social impacts would be expected to continue, if not increase. Further, as with the action or rationalization alternatives, the fishery has changed somewhat during the time since the qualification period, some displacement impacts would be expected upon implementation of the alternative, following resolution of a number of issues resulting from the period of time the fishery has been managed in anticipation of rationalization, such as the status of interim participants.

Three-pie voluntary cooperative alternative

The following series of tables provides information on harvester qualification and allocations under the three-pie alternative, as well as under the two other rationalization alternatives, the individual fishing quota (IFQ) alternative and the cooperative alternative. Allocation of harvest shares are identical under the different rationalization alternatives, as the same qualification criteria is used for each.[1]

Table 4.6-14 provides information on the distribution of BSAI harvest vessels (CVs plus C/P) that would be allocated BSAI crab quotas under the three-pie alternative, by community of ownership of the vessels[2]. For comparison purposes, the average annual number of vessels participating in each fishery category in the period 1991-2000 is provided (calculated using the open years during this period for each fishery). This figure does not correspond to qualifying years but provides a consistent basis for comparison on the community level. Data by year during this period (rather than annual averages) for this table series are provided at the end of Appendix 3, in SIA Attachment 3. As shown, in most cases, an equal or greater number of vessels will qualify for quota allocation than fished on an average annual basis during 1991-2000. Most of the exceptions differ by only a vessel or two. Cases of larger differences are generally for "communities" that have relatively low landings, relatively more non-qualified landings, or both -- Anchorage, other Alaska, other Washington, and other Oregon in the first case; King Cove/Sand Point and Kodiak in the second. For all other communities and fisheries, the annual average number of vessels (or greater) would qualify for allocations under the rationalization alternatives.

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[1] As noted elsewhere, while allocation of shares is identical under each of the rationalization alternatives, the privileges created by shares and their use, differ under the different rationalization alternatives. Under the three-pie voluntary cooperative alternative, if a harvester is a member of a cooperative, the annual allocation would be made to the cooperative for use in accordance with its rules. If the harvester is not a cooperative member, the allocation would be to the harvester who would determine the use of the shares. Under the IFQ alternative, the annual allocation of harvest shares would be made to and could be used by the harvester holding those shares. Under the cooperative alternative, a harvester's annual allocation would be made to the cooperative and would be used in accordance with the rules of the cooperative. If a harvester is not a cooperative member, the allocation would be forfeited. Cooperatives would also operate very differently under the three-pie and the cooperative alternatives. Under the three-pie alternative there is no rigid relationship between a processor and a co-op, nor are there any limits on the number of co-ops of which an entity can be a member (or associate). Under this alternative, IPQs are the only guarantee that a processor will receive crab to process. Under the cooperative alternative, harvesters can belong to only one co-op, and processors can be associated with only one primary co-op (or up to two if it obtains a second crab processing license from another processor). Under this alternative, a co-op is required to deliver at least 90% of its collective IFQs to its associated processor.

[2] Within the quantitative data, assignment of a region or community of ownership for harvest vessels and catcher/processors is based on the vessel ownership and address information as listed in CFEC vessel registration files or NOAA Fisheries federal permit data. As a result, some caution in the interpretation of this information is warranted. It is not unusual for vessels to have complex ownership structures involving more than one entity in more than one region (or for some of the vessels from the Pacific Northwest that spend a great deal of time in Alaska ports to hire at least a few crew members from these ports), but the region or community of ownership provides a rough indicator of the direction or nature of ownership ties (and associated employment and economic activity) when patterns are viewed at the sector or vessel class level. For shoreplant and floating processing entities, regional or community designation was based on the location of the plant or floater itself (rather than ownership address) in order to provide a relative indicator of the local volume of fishery related economic activity, which can also serve as a rough proxy for the relative level of associated employment and local government revenues.

Table 4.6-15 provides information by community of the percentage volume of each individual BSAI crab fishery that would be allocated under the three-pie alternative to vessels owned by residents of that community. In addition, for comparison purposes, it provides the historical volume and value for the harvest of each individual BSAI crab fishery taken by the vessels owned by residents of each named community. A significant number of cells have been suppressed in this table due to data confidentiality restrictions. This table allows a quick comparison of how total fishery percentage allocations would shift between communities under this alternative. It is also easy to see how the alternative would impact community fleet allocations, which would result in larger or smaller allocations in each fishery.

Table 4.6-14 Count of harvest vessels allocated Bering Sea and Aleutian Islands crab, by community and fishery, under the three-pie voluntary cooperative alternative.

State	Community	Fishery	Number of Harvest Vessels Annual Average, 1991-2000		Number of Harvest Vessels Qualifying under the Three-Pie Alternative
			Vessels with "Qualified" BSAI Crab Landings	All Vessels with BSAI Crab Landings	
Alaska	Anchorage	Adak Brown	1*	1*	1*
		Adak Red	0*	0*	1*
		Bristol Bay Red	5	6	6
		Bering Sea Opilio	6	6	6
		Bering Sea Tanner	5	5	6
		Dutch Harbor Brown	1*	1*	1*
		Pribilof Red and Blue	2*	3*	1*
		St. Matthew Blue	2*	2*	2*
	Homer	Bristol Bay Red	8	9	7
		Bering Sea Opilio	8	8	8
		Bering Sea Tanner	8	9	8
		Pribilof Red and Blue	5	5	5
		St. Matthew Blue	2*	2*	4
	King Cove/Sand Point	Bristol Bay Red	6	7	5
		Bering Sea Opilio	5	5	5
		Bering Sea Tanner	6	6	5
		Pribilof Red and Blue	3*	9	5
		St. Matthew Blue	3*	4*	4
	Kodiak	Adak Brown	2*	2*	2*
		Adak Red	2*	2*	5
		Bristol Bay Red	36	44	36
		Bering Sea Opilio	32	38	36
		Bering Sea Tanner	35	44	36
		Dutch Harbor Brown	1*	1*	2*
		Pribilof Red and Blue	7	11	15
		St. Matthew Blue	18	23	22
	Other Alaska	Adak Brown	1*	1*	0*
		Adak Red	0*	0*	0*
		Bristol Bay Red	12	16	12
		Bering Sea Opilio	12	15	13
		Bering Sea Tanner	10	14	13
		Dutch Harbor Brown	1*	1*	0*
		Pribilof Red and Blue	5	8	7
		St. Matthew Blue	4	5	5
Washington	Seattle-Tacoma CMSA	Adak Brown	6	9	7
		Adak Red	4	5	16
		Bristol Bay Red	134	146	158
		Bering Sea Opilio	126	138	147
		Bering Sea Tanner	125	139	166
		Dutch Harbor Brown	6	11	8
		Pribilof Red and Blue	31	36	61
		St. Matthew Blue	56	64	89
	Other Washington	Adak Brown	0*	1*	0*
		Adak Red	1*	1*	2*
		Bristol Bay Red	10	13	9
		Bering Sea Opilio	10	12	8
		Bering Sea Tanner	9	12	9

Table 4.6-14 (Cont.) Count of harvest vessels allocated Bering Sea and Aleutian Islands crab, by community and fishery, under the three-pie voluntary cooperative alternative.

State	Community	Fishery	Number of Harvest Vessels Annual Average, 1991-2000		Number of Harvest Vessels Qualifying under the Three-Pie Alternative
			Vessels with "Qualified" BSAI Crab Landings	All Vessels with BSAI Crab Landings	
		Dutch Harbor Brown	0*	1*	0*
		Pribilof Red and Blue	3*	5	2*
		St. Matthew Blue	3*	5	3*
Oregon	Newport	Adak Brown	1*	2*	1*
		Adak Red	1*	1*	2*
		Bristol Bay Red	9	9	11
		Bering Sea Opilio	8	8	11
		Bering Sea Tanner	8	9	12
		Dutch Harbor Brown	1*	1*	1*
		Pribilof Red and Blue	4	4	5
		St. Matthew Blue	2*	2*	3*
	Other Oregon	Bristol Bay Red	5	6	4
		Bering Sea Opilio	4	5	5
		Bering Sea Tanner	6	7	5
		Pribilof Red and Blue	1*	1*	2*
		St. Matthew Blue	2*	3*	3*
Other States		Adak Red	0*	0*	2*
		Bristol Bay Red	3*	5	6
		Bering Sea Opilio	4	5	6
		Bering Sea Tanner	3*	4	6
		Pribilof Red and Blue	4	4	5
		St. Matthew Blue	2*	2*	5

Notes: Not all communities with historical harvest (1991-2000) were issued allocations under this alternative.
Ownership information for allocations is based on ownership of vessel during most recent relevant BSAI crab activity.
Ownership information for average harvest 1991-2000 is based on ownership of vessel during year of harvest.
Average vessel numbers for individual fisheries calculated using only years each such fishery was open.
"Pribilof Red and Blue" signifies the Pribilof red king crab and Pribilof blue king crab fisheries combined. While managed as separate fisheries under existing conditions, these are combined under the proposed rationalization alternatives.
Cells with values marked * are suppressed in subsequent harvest volume or value tables due to confidentiality restrictions.
BSAI - Bering Sea and Aleutian Islands

Source: Summarized from the NPFMC Bering Sea Crab Data Base / 2001_1 and Allocation File

Table 4.6-15 Summary of harvest vessel allocations by community and fishery, under the three-pie voluntary cooperative alternative.

State	Community	Fishery	Percent of Total Fishery Harvest Value 1991-2000	Percent of Total Fishery Harvest Volume 1991-2000	Percent of Total Fishery Harvest Volume Quota Allocation
Alaska	Anchorage	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	2.31%	2.27%	2.44%
		Bering Sea Opilio	1.79%	1.57%	2.43%
		Bering Sea Tanner	1.03%	0.97%	1.55%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	2.61%	2.75%	*
		St. Matthew Blue	*	*	*
	Homer	Bristol Bay Red	3.26%	3.16%	1.67%
		Bering Sea Opilio	2.63%	2.54%	3.03%
		Bering Sea Tanner	3.94%	2.76%	3.06%
		Pribilof Red and Blue	5.52%	6.31%	11.37%
		St. Matthew Blue	*	*	1.44%
	King Cove/Sand Point	Bristol Bay Red	2.19%	2.18%	1.67%
		Bering Sea Opilio	1.91%	1.89%	1.09%
		Bering Sea Tanner	2.05%	1.90%	1.18%
		Pribilof Red and Blue	7.54%	6.58%	2.04%
		St. Matthew Blue	2.59%	2.78%	2.13%
	Kodiak	Adak Brown	*	*	*
		Adak Red	*	*	48.95%
		Bristol Bay Red	14.65%	14.50%	13.00%
		Bering Sea Opilio	14.17%	14.51%	13.64%
		Bering Sea Tanner	17.18%	17.49%	14.52%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	10.57%	10.40%	10.81%
		St. Matthew Blue	20.47%	20.65%	18.02%
	Other Alaska	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	4.44%	4.55%	3.29%
		Bering Sea Opilio	4.35%	4.33%	4.21%
		Bering Sea Tanner	3.28%	3.30%	2.84%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	8.10%	8.40%	6.89%
		St. Matthew Blue	2.95%	2.98%	3.64%
Washington	Seattle-Tacoma CMSA	Adak Brown	40.90%	40.54%	21.92%
		Adak Red	25.96%	26.51%	11.90%
		Bristol Bay Red	61.09%	61.22%	64.16%
		Bering Sea Opilio	63.49%	64.13%	62.78%
		Bering Sea Tanner	62.91%	63.57%	65.04%
		Dutch Harbor Brown	67.69%	68.97%	63.43%
		Pribilof Red and Blue	50.17%	49.39%	50.68%
		St. Matthew Blue	61.98%	61.02%	63.27%
	Other Washington	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	4.35%	4.40%	3.83%
		Bering Sea Opilio	4.53%	4.26%	3.85%
		Bering Sea Tanner	3.66%	3.62%	3.15%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	5.08%	5.07%	*

State	Community	Fishery	Percent of Total Fishery Harvest Value 1991-2000	Percent of Total Fishery Harvest Volume 1991-2000	Percent of Total Fishery Harvest Volume Quota Allocation
		St. Matthew Blue	3.45%	*	*
Oregon	Newport	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	4.10%	4.26%	4.45%
		Bering Sea Opilio	3.63%	3.55%	4.06%
		Bering Sea Tanner	3.54%	3.15%	4.40%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	6.19%	6.56%	9.07%
		St. Matthew Blue	*	*	*
	Other Oregon	Bristol Bay Red	2.17%	2.11%	1.55%
		Bering Sea Opilio	1.86%	1.74%	1.96%
		Bering Sea Tanner	2.45%	2.37%	2.01%
		Pribilof Red and Blue	*	*	*
		St. Matthew Blue	*	*	*
Other States		Adak Red	*	*	*
		Bristol Bay Red	1.45%	1.36%	2.02%
		Bering Sea Opilio	1.64%	1.48%	2.95%
		Bering Sea Tanner	0.96%	0.86%	2.25%
		Pribilof Red and Blue	2.88%	3.46%	5.11%
		St. Matthew Blue	*	*	2.50%

Notes: Not all communities with historical harvest (1991-2000) were issued allocations under this alternative.
Ownership information for allocations is based on ownership of vessel during the most recent relevant BSAI crab fishery activity.
Ownership information for average harvest 1991-2000 is based on ownership of vessel during year of harvest.
1991-2000 averages based on 10 years, even for those fisheries not open all 10 years.
"Pribilof Red and Blue" signifies the Pribilof red king crab and Pribilof blue king crab fisheries combined. While managed as separate fisheries under existing conditions, these are combined under the proposed rationalization alternatives.
* = cell values suppressed due to confidentiality.
CMSA - Coastal Management Service Area
Source: Summarized from the NPFMC Bering Sea Crab Data Base / 2001_1 and Allocation File

Table 4.6-16 provides information similar to that shown in Table 4.6-15, but expressed in terms of percentage change from the 1991-2000 average for each individual community. Where communities harvest a relatively small percentage of any particular fishery, a small shift may make a relatively large difference in the total harvest for community-owned vessels, as shown in this table. As can be seen in the table, the percentage change varies considerably from place to place and from fishery to fishery. This table also shows, within the confines of confidentiality restrictions, patterns of change between communities. For example, the King Cove/Sand Point fleet, under this alternative, would receive a quota share amount significantly less than their 1991-2000 annual average harvest amount. Newport, on the other hand, would see an increase over historical share in all fisheries for which information can be displayed. Other communities show a more complex pattern of increases and decreases from the 1991-2000 averages, in part due to the lack of information in cells that must be suppressed.

Table 4.6-16 Summary of harvest vessel allocations by community and fishery, under the three-pie voluntary cooperative alternative, as a percentage change from 1991-2000 annual average harvest volume.

State	Community	Fishery	Percent of Total Fishery Harvest Value 1991-2000	Percent of Total Fishery Harvest Volume 1991-2000	Percent Change Between Quota Allocation and 1991-2000 Annual Average Volume
Alaska	Anchorage	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	2.31%	2.27%	7.49%
		Bering Sea Opilio	1.79%	1.57%	54.78%
		Bering Sea Tanner	1.03%	0.97%	59.79%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	2.61%	2.75%	*
		St. Matthew Blue	*	*	*
	Homer	Bristol Bay Red	3.26%	3.16%	-47.15%
		Bering Sea Opilio	2.63%	2.54%	19.29%
		Bering Sea Tanner	3.94%	2.76%	10.87%
		Pribilof Red and Blue	5.52%	6.31%	80.19%
		St. Matthew Blue	*	*	*
	King Cove/Sand Point	Bristol Bay Red	2.19	2.18%	-23.39%
		Bering Sea Opilio	1.91%	1.89%	-42.33%
		Bering Sea Tanner	2.05%	1.90%	-37.89%
		Pribilof Red and Blue	7.54%	6.58%	-69.00%
		St. Matthew Blue	2.59%	2.78%	-23.38%
	Kodiak	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	14.65%	14.50%	-10.34%
		Bering Sea Opilio	14.17%	14.51%	-6.00%
		Bering Sea Tanner	17.18%	17.49%	-16.98%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	10.57%	10.40%	3.94%
		St. Matthew Blue	20.47%	20.65%	-12.74%
	Other Alaska	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	4.44%	4.55%	-27.69%
		Bering Sea Opilio	4.35%	4.33%	-2.77%
		Bering Sea Tanner	3.28%	3.30%	-13.94%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	8.10%	8.40%	-17.98%
		St. Matthew Blue	2.95%	2.98%	22.15%
Washington	Seattle-Tacoma CMSA	Adak Brown	40.90%	40.54%	-45.93%
		Adak Red	25.96%	26.51%	-55.11%
		Bristol Bay Red	61.09%	61.22%	4.80%
		Bering Sea Opilio	63.49%	64.13%	-2.11%
		Bering Sea Tanner	62.91%	63.57%	2.31%
		Dutch Harbor Brown	67.69%	68.97%	-8.03%
		Pribilof Red and Blue	50.17%	49.39%	2.61%
		St. Matthew Blue	61.98%	61.02%	3.69%
	Other Washington	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	4.35%	4.40%	-12.95%
		Bering Sea Opilio	4.53%	4.26%	-9.62%

Table 4.6-16 (Cont.) Summary of harvest vessel allocations by community and fishery, under the three-pie voluntary cooperative alternative, as a percentage change from 1991-2000 annual average harvest volume.

State	Community	Fishery	Percent of Total Fishery Harvest Value 1991-2000	Percent of Total Fishery Harvest Volume 1991-2000	Percent Change Between Quota Allocation and 1991-2000 Annual Average Volume
		Bering Sea Tanner	3.66%	3.62%	-12.98%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	5.08%	5.07%	*
		St. Matthew Blue	3.45%	*	*
Oregon	Newport	Adak Brown	*	*	*
		Adak Red	*	*	*
		Bristol Bay Red	4.10%	4.26%	4.46%
		Bering Sea Opilio	3.63%	3.55%	14.37%
		Bering Sea Tanner	3.54%	3.15%	39.68%
		Dutch Harbor Brown	*	*	*
		Pribilof Red and Blue	6.19%	6.56%	38.26%
		St. Matthew Blue	*	*	*
	Other Oregon	Bristol Bay Red	2.17%	2.11%	-26.54%
		Bering Sea Opilio	1.86%	1.74%	12.64%
		Bering Sea Tanner	2.45%	2.37%	-15.19%
		Pribilof Red and Blue	*	*	*
		St. Matthew Blue	*	*	*
Other States		Adak Red	*	*	*
		Bristol Bay Red	1.45%	1.36%	48.53%
		Bering Sea Opilio	1.64%	1.48%	99.32%
		Bering Sea Tanner	0.96%	0.86%	161.63%
		Pribilof Red and Blue	2.88%	3.46%	47.69%
		St. Matthew Blue	*	*	*

Notes: Not all communities with historical harvest (1991-2000) were issued allocations under this alternative.
Ownership information for allocations is based on ownership of vessel during the most recent relevant BSAI crab fishery activity.
Ownership information for average harvest 1991-2000 is based on ownership of vessel during year of harvest.
1991-2000 averages based on 10 years, even for those fisheries not open all 10 years.
"Pribilof Red and Blue" signifies the Pribilof red king crab and Pribilof blue king crab fisheries combined. While managed as separate fisheries under existing conditions, these are combined under the proposed rationalization alternatives.
* = cell values suppressed due to confidentiality.

Source: Summarized from the NPFMC Bering Sea Crab Data Base / 2001_1 and Allocation File

Beyond the pattern of initial allocations to local fleets, community or social impacts from the harvesting sector under the three-pie alternative will be driven by what happens to the shares following allocation. By design, the initial pattern of distribution of shares follows a distribution of overall GHL/TAC use during a recent period of time so, all things being equal, there should not be a large number of "winners" and "losers" in the initial allocation. There will be, of course, perceived inequities based on differential performance during the qualification period when compared to a longer or a shorter period, or a period (or allocation) that is more heavily weighted toward a greater emphasis on historic participation or more recent time interval. Following the initial allocation, it is expected that there will be consolidation of the fleet, and this consolidation will have a number of community or social impacts. The nature and intensity of these impacts will depend on the relative importance of the local fleet in terms of the overall engagement in, and dependence upon, the crab fishery. As detailed in Appendix 3, communities engaged in the BSAI crab fisheries vary widely in their differential dependence on fleet, processor, and support service sectors.

All of the rationalization alternatives are expected to result in significant harvest fleet consolidation. As detailed elsewhere, under the three-pie alternative the fleet is expected to consolidate the least, but perhaps not at the slowest initial rate. A lesser degree of consolidation would result from the fact that processing shares, regional landing requirements, and community protections would all likely contribute to a broader geographical distribution of landings that would require the use of additional vessels. The pace of consolidation is likely to be quicker at the outset than under the IFQ alternative, however, as a result of the co-op feature of the three-pie alternative. Since harvester cooperative formation and operation is so much more flexible under the three-pie than under the cooperative alternative, it may be expected that fleet consolidation will also proceed more quickly under the former than the latter, but this is uncertain.

Fleet consolidation has the potential to result in community and social impacts as the pattern of vessel ownership (or operation) changes, and this will have different impacts in different communities, as described in Appendix 3. Accompanying the consolidation of vessels will be a loss in crew positions. While overall harvest volumes and values may not decline (and values are likely to increase if rationalization is successful, all things being equal), fewer individuals will benefit directly from the fishery in the harvest sector as employment declines. It is also a likelihood that crew compensation arrangements may change. At present, crew shares are common in the fishery where crew members share in the risk or uncertainty of the undertaking and have an accompanying ability to share in relatively large rewards for high performance. With a large degree of risk of return removed under a rationalization program, there may be movement toward a wage type of compensation structure rather than a share structure. While this may be offset to a degree by the captain's share features of this alternative, it is not clear that this will protect crew interests in the same way. These same issues are common to all of the rationalization alternatives.

While there is community protection built into the processor share distribution under this alternative, there is no similar direct provision for harvester shares. Individuals with harvester shares may be effectively locked into eligible communities by relationships to processors limited by the “cooling off” period and right of first refusal provisions. They would still, however, have the option of leasing shares to other harvesters whose vessels may be from other communities. In such a case, the benefits of the harvesting activity (e.g., crew compensation, vessel support activity) would not flow back to the communities associated with the original vessel (beyond payment to the share holder). (The exceptions to this generalization are CDQ and Adak community allocations that effectively act as regional or community protections for a portion of harvesting share under each of the alternatives.) As noted below, however, eligible communities can purchase harvesting shares under this alternative due to a waiver in sea time requirements that otherwise restrict harvest shares to active participants or original harvest share recipients.

Another type of community or social impact resulting from the three-pie alternative is common to each of the rationalization alternatives. By design, a rationalized fishery obviates the need for a race for fish and, as a result, fishing activity can be expected to slow down and spread out over a longer period of time. Communities with support service business sectors dependent on harvest vessels will experience change. To a degree, in-season support services in coastal Alaska communities are organized at present around the economic inefficiencies of the fishery. Geared for peak or surge demand (as are the harvesters and processors themselves), these businesses are unlikely to experience immediate gains as a result of rationalization as demands for service are no longer time critical in the same way they were before rationalization. With rationalization, time will become less important and money more so when vessels are making decisions about where and when (or how) to obtain services. Over the long run, support service provision is likely to be less volatile than under present conditions, and while the overall sector may shrink, the remaining businesses are likely to experience more predictable conditions allowing better business planning.

Community development (harvest) allocations under the three-pie alternative would benefit two different groups. First, the CDQ groups would benefit from an increase in the number of crab species covered by the program and an increase in the CDQ allocation percentage from 7.5 to 10 percent of covered species. Second, the community of Adak would benefit from a 10 percent allocation set-aside of the western Aleutian Islands golden king crab fishery. This allocation is designed to foster economic growth in the emerging civilian community of Adak based on engagement in the commercial fishery. (As discussed in the Adak community profile in Appendix 3, the Adak community allocation would be administered by a new community-based entity chosen by the community as a whole.) These two community development allocations are common to all three rationalization alternatives.

The three-pie alternative also includes regionalization provisions (as does the IFQ alternative, but not the cooperative alternative). Under a north/south regional split designed primarily to benefit the Pribilof communities of St. Paul and St. George, landings would follow a pattern established in the qualifying period, at least on the regional level (specific community level protection measures are discussed under processing, below). While these patterns would otherwise be expected to change substantially under a rationalized fishery, the north region designation (that portion of the Bering Sea north of 56°20' north latitude) would ensure landings in the north area and, in combination with specific community protection provisions that apply to processing, benefit both St. Paul and St. George (assuming both meet qualifying criteria[3]). Under an east/west split that would only apply to the western Aleutian Islands golden king crab fishery, 50 percent of the landings in the fishery would be earmarked for the western Aleutians (from 174 degrees west longitude, which includes Atka and lands to the west of Atka). This would initially at least primarily benefit the community of Adak as the only site with developed shore processing capability in the region. Community protection provisions specific to harvesting include a sea time eligibility requirements waiver to allow CDQ or community groups that represent qualified communities (those with more than 3 percent of qualified landings in a crab fishery in this program) to purchase harvest quota, and in this way communities could directly control harvest shares.

The three-pie alternative would also have community or social impacts resulting from changes in the relationship between harvesters and processors. With both harvester and processor shares as a part of this alternative, it is assumed that bargaining leverage will shift from baseline conditions, but with the binding arbitration feature of this alternative, the outcome is not clear. Given that most communities do not have a symmetric presence of local processing and a local fleet, changes in the relation between processors and harvesters will impact different communities differently, but in ways that are not predictable at present. The flexibility of cooperative formation, membership, and operation under this alternative also make it difficult to forecast likely harvester related community effects.

Individual fishing quota alternative

As noted above, harvester allocations are identical under all three rationalization alternatives, so the pattern seen in the tables in the three-pie discussion would apply to the IFQ alternative. Harvester consolidation would also occur under the IFQ alternative, but it may follow a somewhat different pace and ultimately be more complete than under three-pie alternative or cooperative alternative conditions. Harvester cooperatives under the other rationalization alternatives may serve facilitate the leasing and the temporary transferral of fishing rights more effectively than under the would been seen under the IFQ alternative. In general, it may be expected that under the IFQ system, such activities would tend to be somewhat more difficult, more permanent, and likely associated with higher transaction fees. Some impediments to consolidation contained in the three-pie alternative are not present in the IFQ alternative. For example, there are no processing-related community-specific protection provisions (such as the "cooling off" period and the community right of first refusal provisions), although regionalization would remain. The sea time waiver for CDQ or qualified community groups representing eligible communities (those with 3 percent or more of qualified landings in

[2] Unfortunately for the purposes of community or social impact assessment, a complete listing of communities that would qualify as eligible for community protection provisions under this alternative cannot be disclosed as eligibility is determined by confidential processing information in three-quarters of the cases. Of the total eight communities that would be eligible, only Unalaska/Dutch Harbor and St. Paul have enough processing entities to permit disclosure that they are on the list.

a fishery under this program) remain in place, and this would result in a beneficial impact to communities. Impacts to support service businesses are likely to be similar to those seen under the three-pie alternative. Community development harvest allocation changes benefitting the CDQ communities and Adak would be the same under the IFQ alternative as under the three-pie alternative.

In terms of the relationship between harvesters and processors, the IFQ alternative clearly gives more leverage to harvesters than would be the case under three-pie conditions, so it is assumed that harvesters will capture more of the rent in landings transactions. That is, harvesters will be released from the race for fish and will also be free to seek new markets or outlets for different product forms (as happened in the halibut fishery). As a result, communities that are more reliant on existing processors may experience some adverse impacts, but this is not clear. While processing companies themselves may be relatively disadvantaged, municipal revenues based on fish taxes would increase if prices increased (irrespective of "at whose expense" the price increase was achieved, short of the processing firm going under).

Cooperative alternative

Community or social impacts associated with the harvest vessel sector under the cooperative alternative would likely be similar to those seen under the IFQ alternative, with one major exception. Under the cooperative alternative, there is no regionalization feature. As a result, there are marked net differences in the community and social impacts under the two alternatives, but these impacts would be driven more by processing sector-related differences than harvest sector-related differences and are therefore discussed under that sector, below. A general level challenge in attempting to determine community impacts associated with the harvest sector under this alternative, however, is that the initial pattern of distribution of quota between cooperatives (and associated pattern of geographic distribution of landings) is unknown, and will not be known until the data from the year prior to alternative implementation are compiled. This year-prior-to-implementation pattern may have a greater or lesser resemblance to conditions seen during the qualifying (or current) period as strategic decisions are made by both harvesters and processors during the critical period in which the cooperative formation process is shaped.

Community impacts are also difficult to foresee under this alternative due to the combination of in-season rigidity and between-season fluidity of the cooperative structure. Although harvesters will have a great deal of freedom in their choice of cooperative membership after the first year (subject to temporarily foregoing 10 percent of their allocation), they will still have a stable linkage to (only) one specific processor. Members of a cooperative must deliver 90 percent of their collective allocations to their associated processor. This is a much more rigid link than for the three-pie alternative – and both of the alternatives containing some form of cooperatives are much more restrictive on harvesters' choices than is the IFQ alternative.

4.6.5.2 Community/social impacts: Catcher processor sector

Status quo alternative

Under the status quo alternative, the fishery would continue in a manner similar to that seen under existing conditions. Impacts similar to those associated with overcapitalization and the race for fish seen in the fishery at present would continue. That is, the status quo alternative would not result in a static or stable situation. Current problematic dynamics would continue, and adverse sector impacts would be expected to continue if not increase. Given the size and distribution of the C/P sector, the adverse consequences to communities would be felt in Seattle and Kodiak, and while likely difficult for direct participants, they would be minimal at the community level.

Three-pie voluntary cooperative alternative

Of the 38 C/P that participated in the relevant BSAI fisheries in this period, 11 would appear to be qualified for C/P shares under the three-pie alternative, as shown in Chapter 3 in the existing conditions section (8 from the greater Seattle area, 2 from Kodiak, and 1 from Anchorage). Some qualified C/P would also receive processor shares for the crab they processed as motherships (purchased from CVs). Of the 27 apparently non-qualified C/P, 25 would be from the greater Seattle area and 2 from Newport. Some of these vessels, although not qualified as C/P because they did not process crab in either 1998 or 1999, would be allocated harvest shares as CVs. In the year 2000, the most recent year for which information is available, 10 C/P participated in the BSAI crab fisheries.

Beyond numbers of vessels, Table 4.6-17 provides information on volume and value for the "big three" BSAI crab fisheries that would be rationalized under this alternative. In terms of types of impacts under the alternative, for confidentiality reasons the sector must be discussed as a whole, and even then only for the three largest BSAI crab fisheries. As shown, for Bering Sea opilio crab, C/P historically (1991-2000) harvested 11.14 percent of total harvest in terms of volume, and 10.76 percent in terms of value. For processing, the percentages are 14.35 percent (volume) and 13.53 percent (value). The processing percentage is larger than the harvest percentage because historically some C/P acted as motherships or floaters once the GHL/TAC was caught and the harvest season was over, but CVs still had crab to unload. Because C/P will be allocated special C/P shares, the "harvest" and "processing" allocations for C/P are equal. In all cases they are less than the historical average (in terms of either weight or value) harvested or processed by this sector. As described in previous sections, some qualified C/P will also receive processor shares for crab they processed while acting as motherships, and some non-qualified C/P will receive harvest quota shares. Neither form of these "separated quota shares" is represented in the "Quota Allocation" column of Table 4.6-17.

Table 4.6-17 Catcher processor 1991-2000 annual average harvesting and processing volume and value and allocation volumes as a percentage of fishery totals under the three-pie voluntary cooperative alternative.

Species	Harvesting			Processing		
	Value 1991-2000 Average	Volume		Value 1991-2000 Average	Volume	
		1991-2000 Average	Quota Allocation		1991-2000 Average	Quota Allocation
Bristol Bay Red King	5.75%	5.84%	4.21%	8.92%	9.25%	4.21%
Bering Sea Opilio	10.76%	11.14%	7.45%	13.53%	14.35%	7.45%
Bering Sea Tanner	9.85%	10.49%	5.94%	13.28%	14.39%	5.94%

Note: "Quota Allocation" is C/P shares only. Some current C/Ps may be allocated harvest shares only if they harvested crab in the qualifying period but did not process crab in 1998 or 1999.

For Bristol Bay red king crab, C/P historically (1991-2000) harvested 5.84 percent of total harvest in terms of volume, and 5.75 percent in terms of value. For processing, the percentages are 9.25 (volume) and 8.92 (value). As with opilio, C/P quota shares will be less than the historical harvesting and processing averages.

For Bering Sea Tanner crab, C/P historically (1991-2000) harvested 10.49 percent of total harvest in terms of volume, and 9.85 percent in terms of value. For processing, the percentages are 14.39 (volume) and 13.28 (value). Similar to opilio and Bristol Bay red king crab, harvesting and processing quota shares will be less than the 1991-2000 historical harvesting and processing averages.

As discussed in Appendix 3, the number of C/P participating in these three BSAI crab fisheries has declined over time, and this is one factor in allocations being less than historical averages. From the information available and because of confidentiality requirements it is not possible to draw conclusions on the probable effects of these allocations on individual C/P economic entities (positive or negative). As discussed in Section 3.4.4.2, ownership of the C/P fleet is highly concentrated in the Seattle area. Even if individual entities experience decidedly negative impacts, it is not likely that there will be effects at the community level for Seattle given the size of the local economy and the presence of other sectors that would presumably gain from any relative loss in the C/P sector. The crab C/P sector as a whole will diminish in size from its historical average, although the number of qualified crab C/P will approximate the number of operations active during the most recent seasons. Whether these operations will be allocated quota shares equivalent to those most recent operations cannot be discussed. Allocations for C/P for the other six BSAI crab fisheries being considered for rationalization, and possible accompanying community effects, cannot be discussed even at this most general of levels because of confidentiality constraints.

Operators in the crab C/P sector anticipate that crab rationalization under the three-pie alternative will have positive effects for those who qualify, even though most believe that the initial allocation to their sector is less than equitable. The sector is also capped as a whole, in that there is no mechanism to form "new" C/P shares from separated harvest and processor shares. Indeed, the sector can shrink further, in that there is a mechanism for the reverse – to form separated harvest and processor quota shares from C/P shares. C/P shares will allow operations to consolidate or adapt in the most economically rational way. Many scenarios people described posited the "stacking" of quota shares in one way or another, whether within a single company or as a cooperative contractual agreement between/among companies. Several operators suggested that larger C/P would be retired as less economically efficient than "pocket" processors in a more time-relaxed rationalized fishery. C/P quota shares would be stacked on a single "pocket" processor to its capability, or some operations may combine C/P quota shares with simple harvest shares, with the "pocket" processor functioning as a CV part of the time. Most operators cited the benefits of the AFA for pollock C/P as a model for what they would expect from crab rationalization – contraction/consolidation of participants, longer periods of operation, higher utilization, more valuable product mix, and a more stable and potentially higher-paid labor force. There is a concern that industry participants with operations in both the BSAI and the GOA will be able to use the benefits of rationalization in the BSAI as an economic advantage in the open access competition GOA fisheries. Possible examples cited ranged from processors with multiple plants and other platforms to harvest vessels that, as members of cooperatives in the BSAI, could arrange their fishing activities to benefit themselves and the other members of their cooperative (and their processor) to the detriment of harvesters confined to the GOA.

Given the pattern of ownership within the sector, social and community impacts associated with sector changes would be concentrated in Seattle, although two enterprises are located in Kodiak and one in Anchorage. While impacts to individual enterprises may be substantial, especially in the long run, it is unlikely that impacts would be felt at the community level in Seattle, Kodiak, or Anchorage. Further, since C/P for the most part harvest what they process (that is, in community terms they are relatively self contained), the overall effects of the three rationalization alternatives would be about the same for catch processors.

Individual fishing quota alternative

As with the three-pie alternative, while impacts may be felt at the individual operation level, no community level social impacts associated with the C/P sector are considered likely under the IFQ alternative.

Cooperative alternative

As with the three-pie and IFQ alternatives, while impacts may be felt at the individual operation level, no community level social impacts associated with the C/P sector are considered likely under the cooperative alternative.

4.6.5.3 Community/social impacts: Processing sector

Status quo alternative

Under the status quo alternative, the fishery would continue in a manner similar to that seen under existing conditions. Impacts similar to those associated with overcapitalization and the race for fish seen in the fishery at present would continue. That is, the status quo alternative would not result in a static or stable situation. Current problematic dynamics would continue, and adverse sector and community or social impacts would be expected to continue, if not increase.

Three-pie voluntary cooperative alternative

Tables displaying specific processor allocations cannot be included in this document as they would necessarily reveal confidential information. This makes discussing changes in such allocations and their effects on communities difficult. Further complications arise because different communities have different combinations of processors, and communities have less than four processors so overall community processing information is confidential. Potential allocations to individual firms cannot be discussed, because while allocations would be public were they to actually be made, at present the calculations of potential allocations are based on specific confidential, single-business performance data. Nonetheless, there are certain general conclusions that can be stated about the "big three" species allocations under this alternative.

During the period 1991-2000, 80 different processors worked on Bering Sea opilio crab. Under the three-pie alternative, 22 processors would receive quota allocations. The top 11 (with no exceptions) would receive more quota allocation than they historically processed (99 percent compared to 73 percent). The rest would receive less allocation than they processed on an average annual basis over the 1991-2000 period. In terms of community effects, this would allow, although not ensure, those larger processors that currently contribute economically to communities through fish tax revenues and private sector economic activity associated with crab processing to continue doing so. Because allocations are to processing companies, however, and not to specific facilities or communities, economic decisions at the corporate level to shift production from one facility to another may have community effects that are essentially unknowable beforehand. (Given what is known about relative costs of crab processing in various communities, St. Paul and other north region communities would appear to be more at risk for such production shifts as a region than would the south region as a whole [defined as the Bering Sea south of 56°20' north latitude, plus the entire GOA], absent regionalization provisions, but there are also community impact concerns associated with consolidation elsewhere, as developed below.)

During the period 1991-2000, 71 different processors worked on Bering Sea Tanner crab. Under the three-pie alternative, 27 processors would receive quota allocations. The top 9 (with 1 exception) would receive more quota allocation than they processed on an annual average basis over the period 1991-2000 (91 percent compared to 64 percent). The rest would receive less allocation than they historically processed. In terms of potential community effects, the situation would be similar to that described for opilio crab.

During the period 1991-2000, 65 different processors worked on Bristol Bay red king crab. Under the three-pie alternative, 19 processors would receive quota allocations. The top 7 (with no exceptions) would receive more quota allocation than they processed on an average annual basis over the 1991-2000 period (89 percent compared to 72 percent). The rest would receive less allocation than they historically processed. In terms of potential community effects, the situation would be similar to that described for opilio crab.

In general then, processor allocations would benefit the larger processors the most, but by design (as was the case with harvester shares) the initial pattern of distribution of shares follows a distribution of overall GHL/TAC use during a recent period of time so, all things being equal, there should not be a large number of "winners" and "losers" in the initial allocation. Also as with the harvesters there will be, of course, perceived inequities based on differential performance during the qualification period when compared to a longer or a shorter period, or a period (or allocation) that is more heavily weighted toward more historic participation or more recent time interval.

Beyond the pattern of initial allocations to local processors, community or social impacts from the processing sector under the three-pie alternative will be driven by what happens to the shares following allocation. Following the initial allocation, it is expected that there will be consolidation of processing, and this consolidation will have a number of community or social impacts. The nature and intensity of these impacts will depend on the relative importance of local processing in terms of the overall engagement in, and dependence upon, the crab fishery. As detailed in Appendix 3, communities engaged in the BSAI crab fisheries vary widely in their differential dependence on fleet, processor, and support service sectors.

Under the three-pie alternative, there are a number of impediments to immediate or sweeping consolidation within the processing sector. First, there are the ownership caps specified by fishery. Current ownership patterns that may exceed these caps will be grand-fathered in, but these companies will be prevented from any substantial future growth. The other two rationalization alternatives impose no similar limits on the consolidation of processing.

A second impediment to consolidation under the three-pie alternative is the regionalization requirement. The north/south region split (based on historic landing patterns) for multiple crab species was designed primarily to benefit the Pribilof communities of St. Paul and St. George. These communities came to be engaged in and dependent upon the fishery to a degree during race for fish conditions through local processing activity and would likely see an exodus of processing capacity under rationalization conditions, absent specific protections. The east/west split of the western Aleutian Islands golden king crab fishery is designed to benefit the communities of the western Aleutian Chain, with the primary beneficiary at least in the near term being Adak, but the area also encompasses the community of Atka. This split is less based on historic patterns than on a desire to foster emerging economic growth based on commercial fisheries in the western Chain and will require additional processing activity in the west over what was seen during the qualifying period.

A third set of impediments to consolidation of processing under this alternative are the community protection measures of a "cooling off" period and a right of first refusal that would apply to eligible communities. Communities with 3 percent or more of qualified landings in any crab fishery in the program would be eligible for this protection in all fisheries included in the program. Based on these criteria, NOAA Fisheries has preliminarily determined that a total of 8 communities would be eligible for these protections: Adak, Akutan, Dutch Harbor, Kodiak, King Cove, False Pass, St. George, St. Paul, and Port Moeller.

The "cooling off" period is a temporary measure that would prevent movement of processing shares from eligible communities during the first 2 years of the program. Given that this "no movement" feature applies to conditions that were extant under the qualification period, this "no movement" provision actually requires movement from the present (that is, post-qualification period) configuration of processing to re-set conditions to those seen under the qualifying period. This may have profound community impacts in a limited number of cases. For example, in the most recent years there has been no crab processing occurring at St. George. If St. George is deemed eligible for protection under this provision, processors would have to move back to St. George and process there for at least 2 years if they desired to use their allocated quota. Again, assuming that in this example St. George is deemed eligible for this type of protection, this would be a significant beneficial impact for the community, which has not recently seen processing activity. (The western Aleutian Island golden king crab fishery would be exempt from the "cooling off" period landing requirements because the West regionalization program is explicitly designed to foster a pattern of landings that differs from the historic pattern.)

The right of first refusal for processor quota share is a longer-term impediment to processor consolidation under the community protection measures in the three-pie alternative. Communities with 3 percent or more of the qualified crab landings in any fishery included in the program are eligible for protection under this measure. Essentially this provision means that a CDQ group, if one exists, or a duly constituted community group[4] if a CDQ group does not exist, can exercise a right of first refusal to prevent processing share from leaving the community.

There are some situations where processing quota can move between communities without triggering a right of first refusal. Except during the 2-year "cooling off" period, movement of quota share can occur freely (that is, without formal transfer) between plants owned by a common firm within the same region as shares are allocated to owning entities, not individual facilities. So, for example, following the "cooling off" period an entity owning multiple plants in the south region could consolidate all its crab processing in one location without triggering any right of first refusal provisions in the communities from which processing allocations were "taken." It is also important to note that a "community" under the community protection provisions of the three-pie alternative is defined as a borough, if one exists, or a first or second class city, if no borough exists. All things being equal, this would mean that (also following the "cooling off" period) consolidation could occur within a borough without triggering a right of first refusal if the processing allocation was not originally made to an entity in a first or second class city. These factors could result in consolidation and processors becoming more concentrated in fewer communities in the south region in a different way than could or would be seen in the north region. Given the tendency of the marketplace to reveal costs and incentives that had not previously been well known, however, this type of movement of processing share (and its related community and social impacts) cannot be assessed with a high degree of certainty.

The right of first refusal process is more complex in some cases than in others due to different priorities assigned to CDQ and borough membership for the purposes of determining "community" under this provision. In the case of a CDQ community within a borough (for example, Akutan in the Aleutians East Borough [AEB]), the local CDQ group (the Aleutian Pribilof Islands Community Development Association [APICDA] in this case) would have the right of first refusal for transfer of shares to any other community either inside or outside of the borough. In other words, in the case of CDQ communities, CDQ status overrides borough status in determining the definition of community for the purposes of community protection: potential transfers from a CDQ community to a non-CDQ community within the same borough

[3] Holdings of a community group would be subject to rules similar to the halibut and sablefish community purchase program. That program requires that the entity be non-profit and submit (1) a certificate of incorporation, (2) verification of its qualification, (3) documentation demonstrating accountability to the community, and (4) an explanation of how the community intends to implement performance standards for the management of its shares. As detailed elsewhere, the community group would be required to submit an annual report and meet certain performance standards, including a requirement to maximize the benefit from use of community shares for community residents, ensuring that benefits are equitably distributed throughout the community, and ensuring that community shares would be fished.

would trigger the right of first refusal provisions. In the case of a non-CDQ community within a borough (for example, King Cove in the AEB), for the purposes of exercising the right of first refusal, the community would be represented by a group that was jointly selected by the community (King Cove) and the borough itself (the AEB). In this case, however, transfers from a non-CDQ community (such as King Cove) to another community within the same borough (whether it is a CDQ community [such as Akutan] or non-CDQ community [such as Sand Point]) would still trigger right of first refusal provisions. In any event, it is possible under the three-pie alternative for individual communities to directly own and control both harvester share (through the waiver of sea time exemption noted under the harvest sector discussion above) as well as processor quota share (through the exercise of right of first refusal, at least in non-CDQ communities).

A different right of first refusal applies to the northern GOA area (defined as that portion of the GOA north of 56 degrees 20 minutes north latitude). In all other areas, a qualifying community has the right of first refusal on processor quota share potentially leaving that specific community (except for quota moving between plants owned by the same firm in different locations within the same region). In the northern GOA area within the larger south region, qualifying communities have the additional right of first refusal for processing quota being sold in all other communities within northern GOA area in addition to their own. In other words, the right of first refusal in all other areas is designed to allow a community to maintain quota share, whereas in the northern GOA area the right of first refusal is designed to allow eligible communities to increase quota share (by aggregating or "sweeping up" quota from communities with less than 3 percent share of qualified fisheries).

As with the harvest sector, there will be community and social impacts resulting from changes to the processor sector as a result of a changeover from a race for fish to a rationalized fishery. As the plants slow down and crab processing seasons lengthen, it is anticipated that peak demands for processing workers will decline. At multi-species plants, workforces will become more stable as deliveries can be scheduled (within limits) to optimize plant operations. Overall employment may be expected to decline in terms of the number of positions needed, but theoretically this could be offset by plants operating longer, requiring fewer workers overall, but more labor hours per position. However, individual workers may work for longer periods but payments to labor may not increase proportionally as the necessity for overtime may be expected to decline. It is likely that multi-species plants will have more flexibility in responding to the longer seasons and slower pace of crab processing under rationalization, while crab specialty plants will be faced with tougher decisions about balancing the trade-offs of increased costs of operations (due to more days of operations) with higher product values resulting from the improved ability to schedule in-season and efficiently plan all aspects of the operation. In any event, with the value inherent in processor quota share allocations, all manner of processors will have a range of options regarding how to adapt to changed conditions under rationalization under the three-pie alternative in a way they would not under the other rationalization alternatives.

In terms of support services changing with a slowing down of crab processing, in general plants tend to be relatively self-sufficient with respect to demand on local (private sector) support services, but longer seasons may increase demand for municipal service provision. (The types of services provided to plants, however, varies widely by community as detailed in Appendix 3.) That some changes will occur is clear; what specifically will change and by how much is less clear. All things being equal, municipal revenues based on processor activity would be expected to stay the same or increase as overall values should be higher under rationalization even if activity in any given period is at a lower level.

The increase in CDQ allocation under the three-pie alternative, like the other rationalization alternatives, will have at least a tangential benefit to the shore processing sector. CDQ allocation will increase from 7.5 to 10 percent of all crab fisheries under the program, and while not subject to share designations and landing requirements of the regionalization program, 25 percent of the allocation (i.e., the same amount of the total allocation attributable to the increase from 7.5 to 10 percent) is earmarked for deliveries to shore based processors. This same provision applies to the other two rationalization alternatives.

As noted in the harvester discussion, the relationship between harvesters and processors will change under the three-pie alternative. Processing quota share represents a departure from previous fishery management strategies and, as a result, some outcomes are likely to be unpredictable. Binding arbitration provisions of this alternative are designed to try to ensure a workable distribution of rents, but much would appear uncertain. Processor ownership of harvesting capability (vertical integration) would be capped at relatively low levels (with existing situations exceeding the caps grand fathered in). How these factors would translate into community and social impacts is unclear.

Individual fishing quota alternative

The IFQ alternative, unlike the three-pie alternative, has no processing quota share, so there is no framework for allocating future effort based on past qualification. With rationalization under these conditions, processing consolidation is expected to take place as fewer plants will be required for processing in a slower, longer season. Thus, absent processor quota share (or processor associated cooperatives), plants may exit the fishery under less than favorable circumstances.

From the community or social impact perspective, there are fewer controls on consolidation under the IFQ alternative than the three-pie alternative. While regionalization provisions remain, there are no community protection measures to limit consolidation within regions. In the north region, for example, all processing could consolidate in St. Paul, leaving St. George with no local processing activity. There is no "cooling off" period to prevent immediate consolidation, and there is no right of first refusal to slow transfers between entities within regions that would remove processing activity from any particular community. Further, there are no provisions under this alternative for caps on ownership of either harvesting capability or harvesting capacity.

It is expected that under an IFQ management approach, rents would shift from processors toward harvesters, but how this would translate into community impacts is unknown. It is assumed that, all things being equal, prices would remain up, and so overall municipal revenues derived from these transactions would be expected to stay at similar levels, but clearly not in all places as consolidation occurs. Impacts to support service sectors related to processing would be expected to be similar to those seen under the three-pie alternative.

Under the IFQ alternative, different types of processors may have different abilities to adapt to rationalization conditions. Large, multi-species plants may be able to optimize their workforces under slower, longer season conditions in a way that smaller crab specialty operations may not. Without the options inherent in processor quota allocations seen under the three-pie alternative, these processors may have a harder time adjusting to new conditions, which would likely result in community and social impacts.

Cooperative alternative

From the perspective of community and social impacts associated with the processing sector, the cooperative alternative is in many ways similar to the IFQ alternative. A major distinguishing factor, however, is the lack of regionalization provisions. Further, unlike the IFQ alternative, it does contain a cooperative mechanism that links harvesters to processors. Under this alternative (as well as the three-pie alternative) harvesters retain the ability to change cooperative (and processor) affiliation, but under the cooperative alternative processors have the protection of being members of a "closed class" of processors. Harvesters will have to sell crab to qualified processors. Still, under this alternative, consolidation could take place rapidly anywhere within the fishery. Without a north region protection, all processing could exit the Pribilof communities of St. Paul (where processing continues at present) and St. George (where processing has not occurred in the most recent years). As detailed in Appendix 3, this would be a severe blow to the economy of these communities. Further, the lack of a west region designation for processing in the Western Aleutian Islands golden king crab fishery would be a significant setback for attempts to foster economic growth based on fisheries in the emerging civilian community of Adak.

This alternative places no caps on the consolidation (or concentration) of processing capacity or on the degree of vertical integration (processor ownership of harvesting capacity). However, there would be a large number of qualified processors under this alternative, any one of which would be restricted to owning no more than two crab processing licenses. Thus, no matter how large any given firm grows or how concentrated the processing sector becomes, there will always be crab processing licenses potentially available for purchase by prospective new entrants. Similarly, there are no limits on harvesters buying processing licenses should they become disenchanted with their available markets. Still, more rather than less consolidation would be expected in the processing sector, and this will undoubtedly result in community and social impacts, but the specifics of those impacts are unclear given the degrees of uncertainty associated with this alternative.

4.6.5.4 Detailed community level impacts

As noted in the introduction to this section, community and social impacts of crab rationalization approaches are discussed both in this section and in an appendix to this volume, and these two discussions, taken together, comprise the Social Impact Assessment for crab rationalization. Appendix 3 (Social Impact Assessment: BSAI Crab FMP EIS Overview and Community Profiles) details the localized nature and intensity of engagement with and dependency on the crab fishery at the community level. This appendix also presents an analysis of the nature, direction, and magnitude of the social impacts likely to result from the crab rationalization alternatives for the series of communities profiled, as well as for the CDQ region. Impacts from the status quo alternative would be similar to the conditions associated with overcapitalization and the race for fish conditions described in detail at the community level in Appendix 3.

4.6.6 Effects of the alternatives on CDQ groups

The CDQ program and CDQ groups are discussed in Section 3.4.5 as well as in the RIR/IRFA in Appendix 1 and the SIA in Appendix 3. Alterative 1 established the crab CDQ program and the percentage of the crab harvest allocated to the CDQ program. Under status quo, CDQ groups are allocated 7.5 percent of the actual harvest of each of the major crab fisheries. The effects of status quo on the CDQ groups is discussed in Section 3.4.5. CDQ groups receive substantial revenues the from crab. According to the Alaska Department of Community and Economic Development, CDQ groups earned a total of $5.7 million in royalties from the harvest of Bristol Bay red king crab and snow crab in 2000 and 2001. The uses of this revenue varies widely between groups, but most are fishing-related investments, scholarships, training, employment services and other projects which are intended to benefit the communities and regions the CDQ groups represent. Additionally, the groups are buying equity in fishing vessels which will harvest crab in both CDQ and open access fisheries. The CDQ program has significant positive effects on the CDQ groups and the communities that belong to these groups.

Alternatives 2, 3, and 4 would increase the CDQ allocation from 7.5 percent to 10 percent (for all fisheries except Norton Sound red king crab) and add a 10 percent allocation for eastern Aleutian Islands golden king crab and western Aleutian Islands red king crab. This change amounts to over a 33 percent increase in the overall crab allocation. Increasing the allocation would increase the royalties earned by CDQ groups and enable them to invest more in projects intended to benefit the 65 communities that belong to CDQ groups.

Under Alternatives 2 and 3, CDQ groups are exempt from the sea-time requirement for purchase of harvester quota share and would be able to acquire quota share in excess of the 10 percent allocation. In addition, the ownership caps for CDQ groups provide the potential for the CDQ groups to own 30 percent of the Bristol Bay red king crab, snow crab and Tanner crab fisheries, 60 percent of the Pribilof red and blue king crab and St. Matthew blue king crab fisheries, and 100 percent of the Aleutian Island brown and red king crab fisheries. And, this is in addition to the 10 percent off the top of the TAC allocated to CDQ groups. These are significant positive direct effects for the CDQ groups. Indirect effects, which are also presumed to be beneficial, include increased profitability from a rationalized fishery. Potential negative indirect effects could result from changes in price negotiations between harvesters and processors under Alternative 2. However, Alternative 2 would also institute mechanisms to ensure fair price negotiations. In addition, under Alternative 2, CDQ groups would have the opportunity to purchase processing quota share and become owners of processing facilities through the right of first refusal mechanism.

4.6.7 Effects of the alternatives on monitoring and enforcement

Catch monitoring in other individual quota programs

Over the past 20 years, numerous individual quota systems have been implemented worldwide. Proponents of individual quotas hypothesize that these systems foster resource stewardship among the shareholders in the resource, which leads to increased voluntary compliance with conservation measures. Some have even argued that quota holders should be allowed to set their own catch quotas because of their vested interest in the long-term viability of the resource (Pearse and Walters 1992). Unfortunately, evidence from previously implemented individual quota fisheries has tended to show otherwise, and practices such as high-grading, illegal discarding, and under reporting of catches occur in many quota based fisheries. To prevent these activities, adequate monitoring and enforcement is vital in implementing any quota based program, including the three alternative programs under consideration for the BSAI crab fisheries. This section looks at experiences from rationalization programs implemented in other regions of the world, and at the halibut/sablefish IFQ program and the AFA pollock cooperative program in Alaska. These experiences are useful for designing the monitoring and enforcement component of a rationalization program.

Canada: Canada's first ITQ program, which has been in place since 1976, rationalized the Bay of Fundy herring fishery. When the program began, quotas were self-imposed by the industry, were not legally binding, and there were no provisions for notification of landings. By some accounts, 50 percent of catch was not reported in some years (Stephenson et al. 1993; Grafton 1996). Despite the lack of compliance, monitoring costs for the fishery were substantial (Grafton 1996). Similar problems plagued other early Canadian individual quota fisheries, such as the Newfoundland otter-trawl cod fishery (Crowley and Palsson 1992). The level of compliance monitoring and enforcement has been increased substantially in both fisheries since that time and a tax on landings is being used to fund the cost of enhanced monitoring.

In part, because of these early negative experiences, more recent Canadian individual quota programs have been developed with a recognition of the inadequacy of traditional voluntary reporting systems and most, if not all, programs begun since 1990 have implemented dockside monitoring systems to weigh all catch at the point of landing. The monitoring is performed by independent companies and paid for by fishermen (Burke and Brander 1999).

Alaska halibut and sablefish fishery: In 1995, IFQ management for Alaskan halibut and sablefish was implemented after several years of consideration in a lengthy public process beginning with the NPFMC (National Research Council 1999). Strict enforcement measures were developed and implemented initially and known enforcement problems in other IFQ programs were circumvented. The first few years put both NMFS and the industry on a steep learning curve, especially when dealing with the reporting technology. Once familiarity with the IFQ program was gained, fraud and NMFS' ability to detect it became more sophisticated. Enforcement of the IFQ program consists of patrol, monitoring, auditing, investigation (Matthews 1997) and Community Oriented Policing and Problem Solving (COPPS). COPPS provides outreach education, a platform for problem solving, and deters minor violators allowing enforcement efforts to be focused on major violators (Passer, 2003).

Of these enforcement components, monitoring is the primary mechanism for deterring fraudulent reporting. Landings are audited through the records of registered buyers and real-time electronic reporting of IFQ landings. This electronic monitoring of landing activity allows IFQ skippers and permit holders to monitor account and vessel landing balances and also serves as a means to validate share transactions and provide documentation for prosecution. There are no designated ports for off-loading IFQ halibut and sablefish, and therefore 100 percent monitoring of off-loading is not possible. The number of violations between 1995 and 2002 was fairly steady, and average vessel compliance rates were high in manned ports at 93 percent. Vessel compliance rates were lower (56-75 percent) when enforcement staffing was low or absent from port (Passer, 2003). High levels of compliance were facilitated by having enforcement measures and personnel in place soon after the IFQ program was initiated.

Initially, costs of enforcement and specifically monitoring were not covered by the quota shareholders. A cost recovery program was established, which assesses up to 3 percent of the ex-vessel value of the catch. Seventy percent of the cost recovery funds are allocated to fund management and enforcement of the IFQ program and 25 percent is available for appropriation to fund a fishermen's loan program.

Observer coverage requirements for the sablefish IFQ fishery are the same as those for the general groundfish fisheries. Vessel length determines observer coverage and those less than 60 ft in length are not required to carry an observer. Observer coverage is not required for halibut IFQ fisheries. However, vessels holding IFQ permits for both halibut and sablefish may conduct directed fishing for each species during the same fishing trip. Since observer coverage is required for sablefish IFQ fisheries, any directed halibut fishing is covered by default.

AFA pollock fishery: The AFA allows authorized pollock C/P, motherships and shoreside processors to form cooperatives. NOAA believes that to manage the AFA pollock fishery properly, NMFS needs data that provides acceptable estimates of the total catch by species and area for each cooperative and meet the monitoring objectives described below. Based on these needs, NOAA Fisheries developed catch monitoring and observer coverage regulations for each sector.

C/P and motherships are required to weigh all catch on NMFS-approved scales. The scales are inspected annually and tested daily when in use in order to ensure that they are accurate. Vessels must also provide an observer work station where an observer can work safely and effectively. The stations must meet specification for size and location and be equipped with an observer sampling station scale, a table, adequate lighting and running water. Each observer sampling station must be inspected and approved by NOAA Fisheries annually. All hauls are observed by NMFS-certified observers. Finally, C/P are required to participate in a vessel monitoring system (VMS).

Shoreside processors must weigh all catch on scales approved by the State. In addition to the requirements implemented by the State, NMFS requires that the scales produce an acceptable printed record of each delivery. Shoreside processors must also have an acceptable catch monitoring plan approved by NMFS. The plan must conform to a series of performance standards that ensure all catch is properly sorted by species and weighed. Each plant is inspected by NMFS staff annually to ensure that all elements of the plan are in place and that the plant is operating according to its guidelines. Shoreside processors must also ensure that each delivery is monitored by a NMFS-certified observer. AFA CVs may only deliver to an AFA processor that has an approved catch monitoring plan in place. Further, they must participate in a VMS and carry observers.

NMFS believes that the program in place for the AFA provides acceptable monitoring of catch in this fishery. All catch is weighed on scales approved by NMFS or the State. This weighing may be observed by NMFS-certified observers that are present during each delivery or processing of each haul. A printed record of the weight of each delivery or haul becomes an auditable source record for reporting that either NMFS or industry may use when the weight of a delivery or haul is contested.

Netherlands: An individual quota program was begun in the Netherlands in 1976 for the sole and plaice fisheries and extended to include cod in 1994 and herring in 1996. The 1998 TAC for the main quota species, was approximately 65,000 mt apportioned among 407 vessels (Davidse 1999a). In the Dutch system, eight separate co-management groups pool the individual quotas of their members and the group is responsible for compliance with the group quota. During the early years of the program, enforcement of regulations was lax and fines were small. Compliance during the period has been described as very low (Davidse 1999b). In response to these and other issues, the government took the following actions:

- set aside 5 percent of each TAC to cover overfishing;
- hired 120 inspectors to monitor all landings; and
- implemented strict regulations regarding when and where catch could be landed.

In spite of these measures, compliance remained low and the following additional measures were taken:

- Eight industry "co-management" groups were formed. These groups became responsible for ensuring that the individual members remain within their quotas;

- The group as a whole can be penalized for overfishing or other violations committed by individual members, the group also has the authority to remove or penalize members as necessary; and

- All catch must be sold at government managed auctions.

These measures appear to have reduced compliance problems substantially.

New Zealand: An individual quota system was introduced in New Zealand in 1986 for all commercially important species. Unlike in most jurisdictions, quotas were originally issued as fixed tonnages, rather than as percentages of TAC. As TACs declined for some species, the government was forced to buy quota back on the open market in order to bring harvest in line with TAC. Based on a 1990 agreement with the fishing industry, the ITQ program was changed from a fixed tonnage program to a percentage of TAC based program. Enforcement is based on a computerized self-reporting system in which the various participants in the industry (fishermen, buyers, and resellers) filed cross-referencing returns. Fishermen are required to file catch reports and quota monitoring reports. Fish may only be purchased by licensed fish receivers, who must comply with extensive record keeping provisions. In theory, all fish sold in New Zealand should be able to be traced back to the original source (Sullivan and Nielander 1999). Though maximum penalties for non-compliance have been increased from $10,000 to $250,000 (New Zealand dollars), quotas are regularly exceeded and illegal activities such as high grading, exceeding quota and illegal selling of fish appear to be commonplace (Leith 1995) and it has been estimated that illegal harvest may have represented as much as 25 percent of the total harvest for some valuable species in some years (National Research Council 1999). Several high-profile investigations have shown that violations can be large and complex, with frequent collusion between fishermen, buyers, and sellers (Sullivan and Nielander 1999).

Iceland: Individual quotas were first introduced in Iceland in 1975 for the herring fishery. Since that time, the quota program has expanded to cover all fisheries. As has been the case in other fisheries, enforcement and monitoring were comparatively lax in the early years of the program. However, the Fisheries Management Act of 1990 established among the most intensive monitoring and enforcement programs of any fishery in the world. A fee of up to 0.4 percent of the estimated catch value is imposed on quota holders to cover the costs of monitoring and enforcement. All catch (or in the case of fish processed at-sea, product) must be weighed by a landings control official at the point of landing on a government approved scale. The landings control official records the landings and determines the species composition of the delivery. In addition, government observers are based intermittently aboard fishing vessels and in the port facilities (Runolfsson and Arnason 1999).

Monitoring objectives for NOAA fisheries-managed quota based fisheries

Based on the lessons learned from other quota based fisheries, NOAA Fisheries believes that any quota based fishery must be developed with sufficient safeguards to meet the following objectives:

NOAA Fisheries must be able to ensure that the total weight, species composition, and catch location are reported accurately for each haul, set or delivery. NOAA Fisheries needs data that will provide accurate and reliable estimates of the total catch by species and area, especially for the quota species. An acceptable catch monitoring system must:

- allow for independent verification of catch weight, species composition and location data for every haul, set or delivery;
- ensure that all catch is weighed accurately; and
- provide an auditable record of the weight of each delivery.

NOAA Fisheries must be able to ensure that regulations governing the fishery are adhered to. Quota share holders have a strong incentive to maximize the value of each pound of their quota. One way to do this is to engage in practices such as illegal high grading, fishing in closed areas, or under reporting catch. An effective quota management program must recognize that the incentive to engage in these sorts of activities is increased under an individual quota system and provide sufficient measures to prevent them.

There must be an authoritative, timely and unambiguous record of quota harvested. All concerned parties (NOAA Fisheries, other agencies, and quota holders) must have access to a single authoritative record which clearly details the amount of quota harvested. To the extent that this record is edited, all parties must receive the edited record.

Based on experience gained under the CDQ and AFA programs, it can be anticipated that NOAA Fisheries or observer estimates of catch will be routinely challenged by quota holders. This problem is avoided to some extent by allowing quota holders or cooperatives to self report catch. However, quota holders have a financial incentive to under report and, without a reliable source for independent verification information, a self reporting system is vulnerable to fraud.

Quota monitoring under the alternatives

Successful implementation of IFQs, IPQs, and cooperatives will necessitate increased monitoring relative to the status quo alternative. A successful monitoring program will have many of the same elements as the monitoring programs developed for the halibut/sablefish IFQ fisheries and AFA pollock cooperative fishery. Final monitoring strategies and the agency responsible for their implementation and operation have not been developed and, based on consultation with stakeholders, these strategies could be modified within the framework of the catch monitoring objectives.

Catch weighing. Under the status quo alternative, crab C/P do not weigh their catch at-sea. Landed weight is calculated based on the application of product recovery rates to the weight of product at the time of offload. Landings delivered by catcher boats to shoreside processors are weighed at the time of delivery on scales approved for trade by the State.

Under the rationalization program alternatives, better control of catch weight monitoring would be required. In the AFA pollock fisheries, for example, each haul made by a C/P must be weighed on a NOAA Fisheries approved scale, and the weighing must be monitored by a NOAA Fisheries-certified observer. Scales are tested daily when in use at-sea and must be approved annually by a NOAA Fisheries scale inspector. Shoreplants must weigh each delivery on a scale approved by the State. The weighing of each haul or delivery is monitored by a NOAA-certified observer and the scales must meet requirements for producing a printed record of each haul or delivery. An IFQ type crab fishery would require similar controls, though the exact details could differ. At a minimum, C/P would be required to weigh all of their catch on motion compensated scales, and catch landed at shoreside processors would need to be weighed on scales approved annually by the State.

A catch weighing program identical to that of the AFA pollock fishery would require a significant increase in observer coverage. However, such an increase may cause a real or perceived shortage of qualified observers. In conjunction with stakeholders, alternatives to full monitoring of the weighing of each pot (on C/P) or delivery (for shoreside processors) could be considered to the extent that those alternatives mesh with NOAA Fisheries monitoring goals.

Catch monitoring plans. Under the rationalization program alternatives, processors would need to develop catch monitoring plans that would be approved by NOAA Fisheries or the State. Catch monitoring plans would need to meet the following performance standards before they could be approved:

- NOAA Fisheries/ADF&G must be able to verify that all crab, including dead loss, is weighed, and reported by species.

- All scales used to weigh crab must be approved by the State, meet minimum standards for accuracy, and must produce paper printouts of scale weights that would be retained by the plant for use by observers and for auditing and verification by other NOAA Fisheries/ADF&G personnel.

- Each plant must develop scale testing and calibration procedures and scales must be tested upon request by NOAA Fisheries/ADF&G-authorized personnel.

- An observer work station must be provided that contains: a platform scale with at least 50 kg capacity, a work table of at least 2 square meters, at least 4.5 square meters of floor space, is free of safety hazards, has adequate lighting, and has a secure cabinet for the observer's use.

- Each plant must have observation area where an observer can see the off-loading of crab, or otherwise ensure that no unobserved removals of catch can occur, between the CV and the location where all sorting has taken place and everything been weighed.

The catch monitoring plans would be reviewed by NOAA Fisheries or ADF&G. Plans that met the standards would be approved. After plan approval, the plant would make any required alterations to the factory and purchase all necessary scales, printers, test weights and other equipment. The plant would then be inspected to ensure that the design met the performance standards.

Vessel monitoring system. Under any rationalization program alternative, C/P and CVs would be required to carry and use a VMS transmitter when fishing. In October of 2000, NOAA Fisheries established VMS requirements for trawl vessels engaged in directed fishing for Atka mackerel. These requirements were extended to vessels participating in the Pacific cod and pollock fisheries in June of 2002. Under these regulations, a vessel endorsed for a fishery requiring VMS must carry and use a NOAA Fisheries-approved VMS transmitter whenever fishing off Alaska. These transmitters automatically determine the vessel's location several times per hour using Global Positioning System (GPS) satellites and send the position information to NOAA Fisheries via a mobile communication service provider. The VMS transmitters are designed to be tamper-resistant and automatic, and the vessel owner is unaware of exactly when the unit is transmitting and will be unable to alter the signal or the time of transmission. NOAA Fisheries has established criteria for the approval of VMS components. A variety of different transmitters made by three companies have been approved by NOAA Fisheries for use off Alaska.

Catch accounting under the alternatives

Catch accounting under the rationalization programs alternative would be complex because each allocation of quota shares would have distinct designations from which catch was deducted. Under Alternative 2, QS would be issued with various regional designations depending on the fishery. These designations determine where and to which processors harvesters can deliver their catch. Captains shares would be allocated to designated individuals and would have specific obligations for use. QS and the resulting IFQ shares could be aggregated for use in a coop. Processor quota would be designated as north or south shares. For the Western Aleutian Islands brown king crab fishery, processor quota would be designated for west of 174°W. Long., which includes Adak. Due to this level of complexity in share designations, Alternative 2 would be the most complex for catch accounting. Additionally, systems to address these catch accounting needs would be novel and unique to this program, for example, NOAA Fisheries does not have a system in place to monitor processor use of processor shares because this would be a new agency function.

Alternative 3 is less complex because the designations of share is less and NOAA Fisheries already has in place a system for catch accounting of an IFQ program that can be the basis for developing a catch accounting system for this program. Under Alternative 3, harvester QS would be designated as CV or C/P shares, and captains shares. The CV shares would be designated north shares or south shares, which determine where harvesters must deliver their catch. Fifty percent of shares for Western Aleutian Islands brown king crab would be designated as western shares. Captains shares would be allocated to designated individuals and would have specific obligations for use.

Alternative 4 would be the least complex for catch accounting because the designation of shares is minimal and NOAA Fisheries already has in place a system for catch accounting of a cooperative program that can be the basis for developing a catch accounting system for this program. Under Alternative 4, cooperative shares would be designated CV or C/P shares, and captain's shares.

For each rationalization program alternative, an adequate catch accounting system will need to:

- accurately account for quota by type and region;
- accurately debit the quota holder's account and track the remaining balance;
- make quota balances available in near real-time to quota holders and enforcement personnel; and
- be closely integrated with the catch monitoring and enforcement programs.

Accounting for landings by ~~CVs~~ will be based on an electronic system. The amounts debited could be audited by comparing the debited amount to the scale printout for that delivery. These reports can be compared against observer data for the same day or against scale printouts to ensure accurate reporting.

Cooperatives would require co-op agreements to be filed with the Secretary. These would be reviewed prior to NOAA Fisheries allocating annual IFQ to the cooperative. The co-op would report its total catch to NOAA Fisheries or ADF&G. To the extent that co-op quota is accounted for at the co-op level, catch accounting will be simplified because there will be fewer entries for NOAA Fisheries/ADF&G to track. Cooperatives will not, however, simplify catch monitoring or enforcement which occurs at the level of the individual delivery or pot. Cooperatives would be expected to have trackable quota balances and would be required to report their crab landings to NOAA Fisheries or ADF&G on a weekly basis using an electronic reporting system approved by NOAA Fisheries. The individual participants in a co-op may also be required to participate in an electronic system so that the landings of individual vessels can be compared against the co-op weekly report.

Additional enforcement requirements under the alternatives

Under any of the rationalization program alternatives, quota holders will have an increased incentive to cheat, which will necessitate increased enforcement, either by the State, NOAA Fisheries, or both. Because a quota based fishery will end the race for fish, seasons will last longer, requiring more time on the part of enforcement personnel. A well developed quota monitoring program that provides tools such as VMS, catch monitoring plans, and enhanced observer coverage can reduce, but not eliminate this increased demand.

Enforcement officers would be needed to patrol and inspect harvesting vessels, tenders and processors. They will also be the primary contact for observers or weighmasters when a possible violation is noted. Special agents would be needed to conduct audits, monitor shipments out of Alaska, and investigate fraud. Additional staff would also be required to monitor VMS transmissions and troubleshoot VMS transmitter problems.

4.6.7.1 State and federal implementation and management roles

Under the FMP, BSAI crab fisheries are currently subject to joint management by ADF&G and NOAA Fisheries. The rationalization program alternatives would significantly change the management of the fishery and would require careful coordination between these two agencies. Implementation of each of the alternative rationalization programs would require an implementation plan that delves into management, monitoring and enforcement issues and requirements for a specific program. Management agencies (NOAA Fisheries and ADF&G) would need to work cooperatively in developing an implementation plan that clearly defines the activities of each agency. The following summary outlines possible approaches to coordinate transition from current management to management under a rationalization program. The discussion focuses on general administration issues associated with a quota allocation and cooperative program, and the regionalization elements, as well as anticipated standards for the monitoring and enforcement of that program.

NOAA Fisheries believes that a quota allocation program developed under a federal FMP involves some inherently federal functions that cannot be deferred. With respect to the crab FMP, other management functions have been and could continue to be deferred to the State. Other sections of this analysis address potential changes to management measures deferred to the State under the current FMP that could result from the implementation of a quota allocation program. At this point, analysts assume that these measures would continue to be deferred to the State and are not further discussed in this section except by reference.

The design of the rationalization program ultimately influences the type of management, monitoring, and enforcement regime that would be required, as well as the respective roles of federal and State management. Under a quota allocation program, the catch histories, quota shares, and ensuing permits compose the fundamental elements of the program that are bought, sold, traded, leased, monitored and enforced. Because the program is an access limitation program implemented under a federal FMP, NOAA Fisheries ultimately would be responsible for the issuance of quota allocations, as well as for many of the other components of a limited entry program, including regulations dealing with appeals, transfers, permit restrictions, etc. These responsibilities would be the same for vessels under a co-op or the IFQ program. The basic difference is that under a co-op, NOAA Fisheries would issue the quota to a group rather than to an individual.

When the halibut/sablefish IFQ program was developed, NOAA-General Council determined that these functions could not legally be deferred. At that time, the Alaska State Attorney General also opined that it was questionable whether the State (Commercial Fisheries Entry Commission) could operate a limited entry program that was not explicitly authorized in State legislation. The ADF&G has general authority to operate deferred programs; however, the question remains whether ADF&G could operate a limited access program or whether, under Alaska statute, the Commission would be the sole authorized entity. The same constraints apply to a quota allocation based crab rationalization program. Notwithstanding this basic legal demarcation of federal responsibility, any delegation of authority to the State under the federal crab FMP would require the development of State regulations and authorities to implement Council intent under the FMP. This duplicative process could be cumbersome and time consuming given the normal Council and BOF processes. Trailing amendments recommended by the Council to accommodate unforseen issues or concerns could also require parallel action by the Board and quickly develop into inconsistent management programs due to different timing or policy perspectives in the federal and State arenas.

Notwithstanding legislative or other legal constraints, splitting or sharing of administrative duties between agencies also would pose technical and practicable difficulties. The agency that issues permits must also regulate the leasing, appeals, and transfers of those permits. Difficulties also would arise if an agency were expected to enforce the terms of a permit that is issued by another agency. For example, if NOAA Fisheries issues a permit to a crab fisherman to catch 10,000 lb. of crab, then NOAA Fisheries would be in the best position to enforce the terms of that permit and prosecute the fisherman if he exceeds or violates the terms of his permit. Even if the State issued or managed permits under federal oversight that provided an appeals process, NOAA Fisheries ultimately would be responsible for ensuring compliance with the permits issued to implement the crab rationalization program under the FMP, as well as compliance of the permitting program with the Magnuson-Stevens Act and other applicable law.

Monitoring and data collection

As discussed above, the management of rationalized fisheries would require more extensive data collection and monitoring. As the AFA has shown, a cooperative program can require less extensive catch accounting, because each cooperative is self-monitoring to some degree. However, cooperatives do not reduce the need for monitoring of landings by coop members, data collection, and enforcement. NOAA Fisheries and ADF&G would work together to develop an implementation plan that coordinates catch accounting, reporting, catch monitoring, data collection, and enforcement. Existing programs which NOAA Fisheries has in place for halibut and sablefish IFQ, CDQ, and the AFA would be starting points, with design changes to fit the characteristics of the BSAI crab fisheries and State-federal cooperative management. Increased data collection under a rationalized fishery would also improve our knowledge of crab stocks. For example, increased observer coverage, VMS, and accurate and timely catch and bycatch accounting would all be improvements over the information available under existing management.

Finally, there are the functions of setting the TAC or GHL and regulating the actual fishing activity (seasons, gear, areas, etc.). These functions traditionally have been deferred to the State. Notwithstanding the likelihood that significant changes to the traditional management of the crab fishery would occur under a quota allocation program, many, if not all, of these measures and functions could remain deferred to the State.

Table 4.6-18 presents some of the activities that would be required to implement, manage, and enforce the quota allocation alternatives for crab rationalization. The information presented is preliminary and would be augmented during the development of an implementation plan. Assumed management agency responsibilities under a crab quota allocation program focuses on new administrative functions required by such a program. Existing management measures deferred to the State likely could remain deferred measures.

Table 4.6-18 Activities involved in the implementation, management, enforcement, and assumed agency responsibility in the Bering Sea and Aleutian Islands crab fisheries.

Activity	Assumed Agency Responsibility
Create the official record of qualifying landings.	NOAA Fisheries would be ultimately responsible, but this activity would require data from ADF&G, CFEC, and Moratorium/LLP licensing information. Also, if it happens, buyback information would be required.
Conduct the application process.	NOAA Fisheries would conduct an application process with an appropriate application period and deadline.
Review and process applications, make determinations, handle appeals, etc.	This activity would involve standard NOAA Fisheries (RAM/Appeals) functions similar to other limited access programs recommended by the Council and approved by NOAA Fisheries.
Calculate and issue annual/seasonal IFQ/IPQ permits.	NOAA (RAM) would issue permits based on the TAC, as determined by ADF&G (Board of Fisheries).
Approve IFQ/IPQ transfer applications.	The administrative activity would be conducted by NOAA Fisheries (RAM).
At-sea catch monitoring	ADF&G would likely increase its observer program to accomplish the required at-sea monitoring to assess total fishery removals, including discards and highgrading.
Monitor in-season landings and quota account management.	The role of NOAA Fisheries and the State would need to be cooperatively developed in an implementation plan for a particular program. Inseason information system likely would require that crab quota holders or co-ops be required to instantly report landings against permits.
Reconcile year-end accounts, calculate overage/underage, etc.	Administrative duty likely conducted by NOAA Fisheries (RAM).
Assess IFQ fees (cost recovery).	NOAA Fisheries (RAM) would administer fee collection program. The State may incur costs directly associated with IFQ program management and enforcement, in which case they would prepare accounting of such expenditures and provide to RAM for inclusion in cost recovery calculation and cost recovery.
Reporting on program activities.	NOAA Fisheries for those functions and activities they would be responsible for; ADF&G on status of stocks and other functions they would be responsible for. Possibility exists for joint reports on enforcement or inseason catch reports.
Implementation of Category 2 and 3 fishery management measures in the FMP.	ADF&G likely would maintain deferred authority under the FMP for Category 2 and 3 measures with oversight of a federal appeals process. These measures include size limits, TACs, management boundaries, sex restrictions, pot limits, registration areas, closed waters, gear placement and removal, gear storage, tank inspections, gear modifications, bycatch limits, and State observer requirements. The potential impacts of crab rationalization on these traditional crab management measures listed under Categories 2 or 3 are discussed earlier in this section of this analysis.

4.6.7.2 Community protection measures, allocation to Adak, and regionalization of quota shares

This section describes the monitoring, management, and enforcement of the community protection measures and regionalization contained in the three rationalization program alternatives, and compares them with the no action alternative.

Major portions of the community protection measures under alternatives 2, 3, and 4 are, by design, intended to minimize the amount of federal and state government oversight, potentially allocating more of the responsibility to local government. The description for each of the primary community protection elements is detailed in the description of alternatives in Chapter 2.

Primary features of community protection measures under the crab rationalization program

Alternative 1, (no action). Status quo contains no direct program community protection measures. Therefore, no monitoring and enforcement effects for these provisions will be analyzed in this section.

Alternative 2, Three-pie voluntary cooperative.

Primary components of community protection measures for the three pie voluntary cooperative:

- regional landing and processing activity requirements;
- an increase in the CDQ allocation to 10 percent;
- right to purchase PQ and QS for qualifying communities and CDQs;
- a "cooling off" period for transfer of PQ by processing companies out of qualifying communities;
- a cap for IPQ allocations in years when TAC exceeds a designated amount;
- waiving of sea-time requirements for communities and CDQ groups to purchase harvest shares;
- a right of first refusal (ROFR) for purchase of processing quota to qualifying communities;
- a 10 percent allocation of the western Aleutian Islands golden king crab TAC to Adak; and
- addition of new crab species to the CDQ allocation (eastern Aleutian Islands (Dutch Harbor) golden king crab fishery and the western Aleutian Islands (Adak) red king crab fishery).

Alternative 3, IFQ program

Primary components of the community protection measures for the IFQ program:

- an increase in the CDQ allocation to 10 percent;
- regional landing requirements;
- waiving of sea-time requirements for communities and CDQ groups to purchase harvest shares;
- a 10 percent allocation of the western Aleutian Islands golden king crab TAC to Adak; and
- addition of new crab species to the CDQ allocation (eastern Aleutian Islands (Dutch Harbor) golden king crab fishery and the western Aleutian Islands (Adak) red king crab fishery).

Alternative 4, Cooperative
Primary components of the community protection measures for the cooperative program:

- an increase in the CDQ allocation to 10 percent;
- a 10 percent allocation of the western Aleutian Islands golden king crab TAC to Adak; and

- addition of new crab species to the CDQ allocation (eastern Aleutian Islands (Dutch Harbor) golden king crab fishery and the western Aleutian Islands (Adak) red king crab fishery).

General monitoring and enforcement effects of community protection and regionalization measures in the no action alternative .

Alternative 2. In Alternative 2, regionalization is intended to protect regional processing activity by geographically designating and restricting use of IFQ and IPQ. NOAA Fisheries would be required to track landings by region to ensure compliance with share designation. The effect of these requirements on monitoring, record keeping, and reporting would be to require that NOAA Fisheries collect data on the location of deliveries for tracking IPQ, class A IFQs, and regionally restricted C shares. Monitoring and record keeping for purposes of tracking the regional designations and use would be very similar to some of the existing tasks that RAM is responsible for under the halibut and sablefish IFQ program.

The electronic reporting system previously described in this chapter would be adequate to accommodate record keeping of the use of quota with regional landing designations for both harvesting and processing sectors. A review of either real-time landings data or regularly reported landings data is likely adequate to reveal accounting discrepancies between permissible landing locations for quota share and actual landing records. It is assumed that any discrepancies would be forwarded to NOAA Fisheries Enforcement either at or shortly after the date of landing.

It is anticipated that regional designations on quota would lead to the need for new enforcement resources as compared to the status quo. It would be difficult to project the frequency, type and enforcement budget changes that may result from regionalization, but some qualitative assumptions are suggested for this feature of the program. In the case of the regional landing requirements, there may be incentives to illegally offload crab in one region and report the landing in the other region. This type of landing would not avoid taxation, but would merely serve operational efficiencies for harvesters. The costs of fraudulent reporting of landing, processing and shipping of significant amounts of BSAI crab product would involve significant risk of civil or criminal penalties.

Alternative 3. Under the alternative 3 IFQ system, regionalization would be applied to harvesting quota only. The boundaries of the defined regions would be the same as in Alternative 2. The monitoring strategies and enforcement of the regional landing requirements for Alternative 3 are likely to be similar to those for Alternative 2. The NOAA Fisheries quota accounting system that would be required to track the regional location use of IFQ would be very similar, if not identical, to the accounting of regional locations as previously described under Alternative 2.

Alternative 4. Alternative 4 has no specific regionalization component and the monitoring and enforcement effects of regionalization are not applicable to this alternative.

Community purchase of quota including the Right of First Refusal*: *Monitoring and enforcement implications

Alternative 2. Under Alternative 2, the Community protection elements provide three quota purchase options for qualifying BSAI or GOA communities. First, groups representing qualifying communities in the BSAI and GOA could purchase harvesting quota subject to rules similar to those recommended by the Council for the halibut and sablefish IFQ program. Second, groups representing qualifying communities could purchase processing shares from a processor through a ROFR on sales of processing shares from the community. Third, groups representing qualifying communities could purchase PQ in the open quota market (outside of the ROFR).

Two issues arise in implementing these provisions. First, qualifying communities must be identified and the entities that may purchase shares on behalf of the communities must be designated. Second, once entities that may purchase shares are identified, transfer and ROFR must be monitored and enforced. The ROFR creates an affirmative right that is substantively different from the purchase rights, which involve only voluntary transactions. Therefore, the discussion of the implementation of the ROFR is separated from the discussion of the monitoring of shareholdings, which is common to shares purchased both under the ROFR and through voluntary community purchase transactions.

Identification of eligible communities and designation of entities

The first task in administering community protection provisions is to identify eligible communities. Since eligibility is based on the amount of landings, which are recorded on fish tickets and used for making share allocations, identification of qualifying communities should be relatively straightforward. Only in the case of floating processors could the tracking of landings be complicated. Landings of floating processors, however, should be traceable to specific geographic locations because of the State requirement that processors file their location of operation prior to processing landings. Based on these criteria, NMFS has preliminarily determined that the eligible crab communities are as follows: Adak, Akutan, Dutch Harbor, Kodiak, King Cove, False Pass, St. George, St. Paul, and Port Moeller. However, Adak is not eligible for the right of first refusal provision.

The specific entity that can exercise ROFR or purchase shares on behalf of each community must be designated within a time frame that would allow for the entity and processors to develop and sign contracts prior to a processor's application for PQS. The process is simplified for CDQ communities because CDQ groups would be the entity eligible to exercise any ROFR or purchase shares on behalf of the community. For non-CDQ communities, the entity eligible to exercise the ROFR or purchase shares on behalf of a community will be identified by the eligible city, except if an eligible city is in a borough, in which case the eligible city and borough must agree on the entity. Requiring the borough and city to agree on an entity avoids the need for the State or NOAA Fisheries to mediate a dispute. Requiring the community to affirmatively designate the entity that will act on its behalf simplifies administration of this provision. Once designated, the community group or entity and the processor will enter a contract that defines the ROFR. This contract will be required as part of a processor's application for initial processor quota share. As part of the application process, NOAA Fisheries will confirm that a contract exists establishing the ROFR. This burden is likely to be limited given that 10 or fewer communities will qualify for the right and approximately 30 processors are likely to be required to enter contracts.

Administration of the ROFR

The ROFR will be enforced by civil contract law. The objective of this method of enforcement is to avoid overburdening NOAA Fisheries with adjudicating cases involving the ROFR and to recognize the contractual nature of the right. Although ROFR specific contract provisions adopted by the Council and enacted by statute will be enforced through contract law, NOAA Fisheries will assist communities in making the right effective by (1) requiring that signed contracts be a part of a processor's complete application for initial issuance of processor quota share, and (2) requiring that a processor's request to NOAA Fisheries for transfer of PQS or IPQ out of an eligible community be accompanied by documentation signed by either a CDQ group or community entity that it did not wish to exercise ROFR. Because intra-company transfers are exempt from the ROFR, the agency will need to assess common ownership of plants and determine whether IPQ have been transferred for purposes of the ROFR. Since the agency will also need to monitor and enforce use caps, the additional burden of determining when use of shares outside a community is a transfer for purposes of the ROFR is likely to pose a minimal burden. Each of these monitoring activities is likely to add a minor burden to NOAA Fisheries. Collectively, the burden is likely to be insubstantial. The burden of the ROFR on the agency is mitigated by providing that the right is to be enforced contractually by the groups holding the right.

Oversight and management of share holdings

Alternative 2 defines the entity that could hold shares on behalf of a community. For CDQ communities, CDQ groups would be the entity eligible to exercise any ROFR or purchase shares on behalf of the community. Ownership and management of harvest and processing shares by CDQ groups would be subject to rules similar to CDQ regulations. The current CDQ management and oversight regulations should be adequate to ensure that the benefits of purchased harvest shares are responsibly held and managed and would minimize the requirement that new regulations and administrative obligations be undertaken. A more complete description of those requirements appears in Section 3.9.1 of the RIR.

For non-CDQ communities, each qualified community could identify the entity that would be permitted to purchase shares on its behalf. These holdings would be subject to rules similar to the halibut and sablefish community purchase program. That program requires that the entity be non-profit. In addition, the entity would need to submit: 1) a certificate of incorporation, 2) verification of its qualification, and 3) documentation demonstrating accountability to the community.

The requirements of the halibut and sablefish community QS program are less stringent than the oversight and management of the CDQ program. The community purchase rules require less detail than the CDQ community development plans.[1] Imposition of CDQ requirements under Alternative 2 could be cost prohibitive, especially for new non-profit community groups interested in purchasing interests in fisheries. Under the halibut and sablefish community purchase rules, the entity would be required to meet performance standards. The performance standards would require the group to (1) maximize benefit from use of community shares for community residents, and (2) ensure that benefits are equitably distributed throughout the community. Communities purchasing shares would be subject to performance standards, with voluntary compliance monitored through the annual reporting mechanism and evaluated when the program is reviewed. Since these groups receive no direct allocation, these less stringent measures are likely more appropriate for non-CDQ community groups purchasing shares.

Alternative 3. The IFQ program contains a provision for the community purchase of QS, similar to the provision in Alternative 2. The monitoring and enforcement provisions of this provision under both alternatives would be the same. Alternative 3 contains no ROFR provision, so no monitoring and oversight of that provision would be required.

[1] Community development plans must include descriptions of projects; community development information; business information; project schedules; employment, vocational, and educational programs; a description of existing infrastructure; a description of capital uses; and a description of short and long term benefits.

Alternative 4. The cooperative program contains no provisions for community purchase or ROFR.

"Cooling off" period*: *Monitoring and enforcement implications

Alternative 2. The 'cooling off' period would prevent movement of processing shares from qualifying communities during the first two years of the program. To allow for coordination of deliveries, the lesser of 10 percent or 500,000 lbs of IPQs could be removed from the qualifying community. There are also some areas of the BSAI that are exempt from the cooling off period landing requirement that would be required to be identified in regulation.

The cooling off period would require NOAA Fisheries to first designate qualifying communities and identify shares subject to the provision. Since qualification is based on share allocations, determining the shares subject to the provision is relatively redundant with other administrative actions of the agency under the program. The agency would also need to track geographic use of shares during the first two years to ensure that the allowable 10 percent or 500,000 pound transfer of IPQs is not exceeded. This also overlaps with administration of other aspects of the program. These two actions are likely to be a minimal burden to the agency. Enforcement actions for violations of this provision are likely to be relatively simple since landings records should provide evidence of any violations.

Alternative 3. The IFQ program does not contain a cooling off provision.

Alternative 4. The cooperative program does not contain a cooling off provision.

Cap for designating individual processing quota in high total allowable catch years: Monitoring and enforcement implications

Alternative 2. The cap on the issuance of IPQ in the Bristol Bay red king crab and *C. opilio* fisheries would simply require that NOAA Fisheries limit the allocation of IPQ in years that the TAC exceeds the specified caps. The provision should be simple to implement, as the agency would withhold IPQ in excess of the cap and issue regionalized Class B IFQ for the TAC in excess of the cap that would have been Class A IFQ but for the cap. The burden of implementing this provision is likely to be minimal.

Alternatives 3 and 4. There is no cap for processing quota under these alternatives and no monitoring or enforcement effects associated with this action.

Direct allocation of Aleutian Islands golden king crab to Adak: Monitoring and enforcement implications

Alternatives 2, 3, and 4. Each of the alternatives to the status quo include an allocation of up to 10 percent of the Western Aleutian Islands golden king crab total allowable catch to the community of Adak for fisheries related economic development. The allocation would be made to a non-profit entity that has a board of directors elected by the residents of Adak. The alternatives specify, that if the non-profit corporation cannot be created in time to receive the allocations when they are first authorized, the Aleut Enterprises would be allowed to receive the allocations and hold the proceeds from the allocations in trust for up to two years. If the non-profit entity is able to receive and use the allocations after two years, the Council would reassess the future of the Adak allocation. It will most likely take at least one year from the time of Council final action to develop and implement the regulations for crab rationalization. Thus, there should be sufficient time available for the Adak non-profit entity to organize and be capable of receiving allocations in the first year the program is implemented (2005).

This allocation is not part of the crab IFQ fisheries, but would be managed as a separate commercial fishery by the State of Alaska in a manner similar to management of the crab CDQ fisheries. The State would establish pre-season and in-season management measures, catch monitoring requirements, and catch reporting requirements. The State also would be responsible for enforcing the fishery management measures it implements for the allocation to Adak.

Government oversight of how the Adak community non-profit entity uses the allocation for "fisheries related purposes" also would be deferred to the State under the FMP. NMFS would have no direct role in oversight of the use of this allocation. The State would implement regulations related to allocation use procedures, the requirement for a fisheries development plan, investment policies and procedures, and auditing procedures. The State would define what is meant by "fisheries related purposes" and would report directly to the Council about whether the Adak community non-profit entity was using the allocations consistent with the purpose of the program and in a manner that the benefits derived from the allocations accrued to the community of Adak and achieved the goals of the fisheries development plan. Finally, the State would provide the Council with an implementation review of the program at some appropriate time so that the Council can evaluate the allocation. If the residents of Adak, the Adak non-profit entity, or any member of the public were not satisfied with a decision made by the State in oversight of the Adak allocation, they could petition the Council to consider the issue and, ultimately, could appeal to NMFS under the appeal provisions of the FMP.

CDQ Information Reporting Requirements

One of the critical differences between the proposed Adak allocation and the CDQ Program relates to the allocation process and reporting procedures. Allocations of CDQ are made to the CDQ groups, representing one or more communities, on the basis of the groups' approved Community Development Plans (CDPs). Federal regulations explicitly state that these are harvest privileges that expire upon expiration of a CDP; thus, when a CDP expires, further CDQ allocations are not implied or guaranteed (50 CFR 679.30 (a)). Each proposed CDP includes a list of new and existing projects and a request for quota with which to support those projects. Because the groups typically request more than the available quota, it is a very competitive process in which the groups vie for a limited amount of CDQ. The Adak allocation is different in that it is an allocation to one community, absent any competition from other communities. Thus, the primary reason the crab allocation to Adak would be reduced or terminated, biological reasons notwithstanding, would be due to a determination that the benefits were not accruing to the community and Adak was not sufficiently achieving the goals of its fisheries plan. This absence of competition, combined with not having to apply for the quota on a continual basis, creates a much different environment than that of the CDQ Program.

The most prominent of the CDQ reporting requirements is the proposed CDP. The Council's June 2002 action[2] on the administrative and policy elements of the CDQ Program included a provision that would establish a three-year allocation cycle, meaning the CDPs must be submitted every three years. Under the CDQ Program regulations, a CDP must include a community eligibility statement, community development plan, business plan, statement of the applicant's qualifications, and a description of the managing organization

(50 CFR 679.30 (a)). All of this comprises a comprehensive CDP, and as specified, is submitted to the State for recommendation to the Secretary of Commerce. In addition, each CDQ group must submit quarterly reports, an annual progress report (including an audited financial statement), annual budget report, annual budget reconciliation report, and any amendments to the approved plan mid-cycle. These reports, in combination with the CDP, encompass the fundamental information requirements in the current CDQ Program.

Related to the competitive nature of the CDQ Program is the need to evaluate the CDPs based on a set of criteria. While the entity representing Adak would not be competing with any other entity for that allocation, there must be criteria by which the plan can be evaluated to determine whether Adak is using the allocation to achieve the purported goals. If, like the CDQ Program, the allocation is intended as a privilege which may be revoked or suspended, there must be standards by which to measure the community's success. The CDQ Program uses the evaluation criteria in State regulations to evaluate the CDPs and determine how well each group is providing benefits to its communities and meeting the milestones identified in its plan. It is also assumed that corresponding regulations would include the opportunity for Adak to comment on and appeal a recommendation to reduce or terminate the golden king crab allocation.

While the current criteria only exist in State regulations, the Council's June 2002 motion consolidated and modified the following criteria for evaluating the CDPs to be placed in Federal regulations:

1. Number of participating communities, population, and economic condition.
2. A CDP that contains programs, projects, and milestones which show a well-thought out plan for investments, service programs, infrastructure, and regional or community economic development.
3. Past performance of the CDQ group in complying with program requirements and in carrying out its current plan for investments, service programs, infrastructure, and regional or community economic development.
4. Past performance of CDQ group governance, including: board training and participation; financial management; and community outreach.
5. A reasonable likelihood exists that a for-profit CDQ project will earn a financial return to the CDQ group.
6. Training, employment, and education benefits are being provided to residents of the eligible communities.
7. In areas of fisheries harvesting and processing, past performance of the CDQ group and proposed fishing plans in promoting conservation based fisheries by taking action that will minimize bycatch, provide for full retention and increased utilization of the fishery resource, and minimize impact to the essential fish habitats.
8. Proximity to the resource.
9. The extent to which the CDP will develop a sustainable fisheries-based economy.
10. For species identified as "incidental catch species" or "prohibited species," CDQ allocations may be related to the recommended target species allocations.

While some of these criteria do not apply to a one community, non-competitive allocation, this list shows what "CDQ-type" management might entail. It would be necessary to develop a set of criteria appropriate for use in evaluating a fisheries development plan provided by the Adak non-profit organization, whether it be similar to what is used currently in the CDQ Program or something different. Under the proposed language, the State would conduct the review of the fisheries development plan provided by Adak at a specified interval. For example, mirroring the Council's June 2002 action on the CDQ Program, this would require Adak to submit a fisheries development plan for review and approval every three years.[3] In this sense, the allocation to Adak would be interpreted similarly to the allocations made in the CDQ Program in that it would represent a privilege which may be revoked or suspended if the managing entity does not succeed in providing benefits to the community and implementing its fisheries development plan. This is intended to instill a level of responsibility in the managing entity to demonstrate its successes and be accountable to the community it represents.

The Council intended, and recently confirmed through its June 2002 action on the CDQ Program, that the State take primary responsibility for qualifying eligible communities and reviewing and making recommendations on the CDPs. The State was deemed the entity responsible for applying the criteria and procedures and for ensuring that each group meets the steps outlined in the allocation process. The Council is consulted on the State's initial recommendations, and the Secretary holds final approval authority and releases quota to the CDQ groups as appropriate. Under the proposed option for the Adak allocation, the State would take primary responsibility to perform an implementation review to ensure that the benefits are accruing to the community and the fisheries plan is being implemented, similar to the role played by the State in the CDQ Program. It is assumed, however, that the final approval of a fisheries plan based on an allocation of Federal fisheries quota would remain with NMFS.

CDQ Prior Approval Requirements

The other primary element of government oversight of the CDQ Program is the requirement that certain activities by the CDQ group and their subsidiaries be approved by the State and NMFS before they are undertaken (i.e., prior approval). It is through the initial approval of the proposed CDP and through substantial plan amendment requirements that the State and NMFS exercise the authority to review and approve investments before they are made. Substantial amendments to the CDP require a written request by the CDQ group to the State and NMFS for approval of the amendment. The State must forward the proposed amendment to NMFS with a recommendation as to whether it should be approved or disapproved, and NMFS must notify the State in writing of its decision. The Council's June 2002 motion clarified that government oversight extends to subsidiaries controlled by CDQ groups, and 51 percent minimum ownership denotes effective management control or controlling interest in a company.

The practical implication of imposing this requirement on the community entity representing Adak is that it would require the entity to keep its fisheries development plan up to date and submit any changes after the initial approval of the plan to the State and NMFS. If the entity wanted to substantially amend the plan to make a different investment or engage in a different business activity not covered in the plan, it would have to submit a written request to the State and NMFS for approval. For the purposes of the CDQ Program, a substantial amendment is currently defined as including, but not limited to: any change in the list of communities represented by the CDQ group or replacement of the managing organization; a change in the

[3]Establishing a foreseeable allocation cycle and enabling the groups to plan ahead for the time, staff, and cost involved in the development of the CDPs is intended to allow the groups more stability in their development and potentially increase the efficiency of their operations. The intent of the three-year allocation is to allow the CDQ groups relative stability and reasonable expectations for the CDP without establishing permanent, or long-term, allocations. The Council noted that a three-year cycle is likely long enough to allow the groups the necessary flexibility in their CDP development, but short enough to keep the groups accountable to the performance standards and milestones identified in their CDPs. Given that the only practical mechanism for the State and NMFS to adjust the allocations is through the allocation process, the Council recommended a three-year cycle in order to retain this level of government oversight.

group’s harvesting or processing partner; funding a CDP project in excess of $100,000 that is not part of an approved general budget; more than a 20 percent increase in the annual budget of an approved project; more than a 20 percent increase in actual expenditures over the approved annual budget for administrative services; a change in the contract between the group and its harvesting or processing partner, or a material change in a CDQ project.

In sum, the information and reporting requirements, including the requirement for prior approval, make up the critical elements of government oversight within the CDQ Program. There are numerous other requirements comprising the CDQ Program, including the requirement that CDQ Program revenues are restricted to fisheries-related projects and investments. While this requirement was relaxed in the Council’s June 2002 motion to allow each CDQ group to invest up to 20 percent of its previous year’s pollock CDQ royalties in non-fisheries related, in-region, economic development projects, the first priority of the program continues to be to strengthen the fisheries-related economies in the region. Similarly, the proposed goal of the community allocation to Adak is: “to provide Adak with a sustainable allocation of crab to aid in the development of local seafood harvesting and processing activities.”

4.6.7.3 Binding arbitration

Binding arbitration is a component of Alternative 2. Alternatives 1, 3, and 4 do not contain a binding arbitration provision.

An effective binding arbitration program will require careful oversight and administration. A system of rules will define the program and ensure that participants in binding arbitration operate within anti-trust laws. To mitigate unintended effects, the program will need to be adaptable. Adaptation is particularly important given the novelty of the program. Alternative 2 provides that oversight and administration of the binding arbitration should be conducted in a manner similar to the AFA cooperative administration and oversight. System reporting requirements and administrative rules would be developed in conjunction with the Council and NOAA Fisheries after selection of the preferred program.

Administration and oversight of the arbitration program would be patterned after NMFS administration of the AFA cooperatives. NMFS oversight of the cooperatives focuses on elements of that program that are important to public management of the fisheries. Cooperatives are required to report harvests, bycatch, discards, monitoring procedures, and penalties in an annual report to the Council and NMFS. On a more general level operations of the cooperatives are overseen by requiring cooperatives to file a copy of the cooperative's contract 30 days prior to beginning fishing under the contract. These reporting requirements provide NMFS and the Council with information necessary for determining whether the program is functioning effectively. In the case of binding arbitration, requirements could be developed for the filing of signed arbitration agreements and price contracts, best offers, identifying the agreed upon arbitrator and independent market analyst, and similar general requirements of the program. General reporting requirements and a general oversight role for NMFS should provide both NMFS and the Council with the information necessary to determine whether the program is serving its stated purpose without creating cumbersome requirements for modification and operation of the program. Under this model, minor modifications could be adopted by the parties without direct involvement of NMFS or the Council. The scope of these permitted changes could be defined by the Council and NMFS and could be limited to aspects of the program that are less appropriate for government involvement. Limiting government involvement will remove some of the restrictive requirements of public decision making. The parties could petition the Council for changes in the program, if they believed that it was not serving its purpose or needed modification.

Additionally, the Council directed staff to prepare an analysis, for delivery to the Council 18 months after the fleet begins fishing under the crab rationalization program, that examines effects of the 90/10 A share/B share split and the binding arbitration program on the distribution of benefits between harvesters and processors in the BSAI crab fisheries. On receiving the analysis, the Council will consider whether the 90/10 split and arbitration program are having their intended effects and whether some other A share/B share split (e.g., 80/20, 70/30, or 50/50) may be appropriate.

4.6.7.4 Crew loan program

This section describes the effects of the crew loan program as it relates to monitoring, management, and enforcement actions that may be contemplated by NOAA Fisheries. The crew loan program is a component of each of the rationalization program alternatives 2, 3, and 4. A crew loan program does not exist under Alternative 1. The crew loan program was part of a suite of captain and crew proposals that included a special allocation of harvesting quota to captains, called C shares. The loan program is intended to provide fishermen with financial assistance in buying quota share in the BSAI crab fisheries, through the financing or refinancing of the purchase cost of quota share in these fisheries through long-term fixed rate loans, in a manner that is similar to the halibut and sablefish captains and crew loan program.

All three alternatives provide for the development of a loan program to assist captain and crew purchase of quota share with the following provisions:

> 1.8.1.8 Loan program for crab Q.S.
>
> A low-interest rate loan program consistent with M.A. provisions, for captains and crew purchases of QS, shall be established for QS purchases by captains and crew members using 25 percent of the Crab IFQ fee program funds collected.
>
> In addition to the loan program proposal advanced by the Council, the captain's QS committee proposed additional options concerning the proposed loan program:
>
> These funds can be used to purchase A, B, or C shares.
>
> Loan funds shall be accessible by active participants only.
>
> Any A or B shares purchased under the loan program shall be subject to any use and leasing restrictions applicable to C shares (during the period of the loan).
>
> NMFS [NOAA Fisheries] is directed to explore options for obtaining seed money for the program in the amount of $250,000 to be available at commencement of the program to leverage additional loan funds.

It is assumed that the crab captain and crew loan program would rely on the infrastructure, monitoring, and enforcement developed for the North Pacific halibut and sablefish loan program.

Administrating entity for the loan fund and associated record keeping, reporting and management responsibilities: The BSAI crab crew loan program would be administered by the NOAA Fisheries Financial Services Division, the same institution that manages the North Pacific Loan Program developed for the halibut and sablefish IFQ fishery in 1998. The NOAA Fisheries Financial Services Division would have considerable management and monitoring responsibilities for the loan fund including design of application instruments, auditing of applications, selection of qualifying captains and crew that request loans, financial management of the revolving loan fund, and possibly conducting lotteries for selection of pre-qualified applicants. Though the administrative entity that would handle most of the crab loan program is in place, additional costs would be associated with the recordkeeping, monitoring, management, and enforcement of the crab captains and crew component. At this time, there is no estimate of additional costs. In addition to oversight by the NOAA Fisheries Financial Services Division, the RAM program would be required to assist by verifying current holdings of quota share and other assets during the loan application period.

Monitoring and enforcement associated with application and selection of loan recipients: Loan funds can be used to purchase IFQ. Loan funds shall be accessible by active participants only. NOAA Fisheries Financial Services Division would need to invest review, auditing, and potentially apply enforcement actions against individuals utilizing loans awarded from this new program. This branch would be responsible for assuring that loans are used expressly for the purchase of harvesting shares. A significant component of the management responsibilities would be to perform the standard types of due diligence review and credit investigations for each loan applicant.

Management of the loan program would also include determination of whether applicants:
- are citizens of the U.S. and are free of any relevant civil and criminal history;
- have outstanding loans with a federal agency;
- are properly certified under various labor law requirements for workplaces in the U.S. and Alaska;
- meet the requirements defined under the Merchant Marine Act for creditworthiness; and
- meet the minimum requirements for sea time in a fishery.

Two of these management functions are already part of the quota share transfer responsibilities of RAM for the halibut and sablefish IFQ program. RAM includes the verification of citizenship and sea time for quota participants.

Compliance with limitations on use and transfers: For each of the rationalization alternatives, it is anticipated that the NOAA Fisheries Financial Services Division would also inform potential loan recipients that they would be required to comply with all of the other provisions of the program relevant to the ownership, use, and transfer of quota. Any shares purchased under the loan program shall be subject to any use and leasing restrictions applicable to C shares (during the period of the loan).

Initial implementation costs for the loan program: It is worth mentioning that the captains and crew loan program developed under the crab rationalization alternatives would impose some significant costs on NOAA Fisheries during the rulemaking and implementation phases. The implementation tasks, time table, and staff inputs of the North Pacific Loan Program included approximately one person per year of NOAA Fisheries Financial Services Division. As that program was one of the first applied loan programs under the amended SFA, and the crab fishery has been a modestly sized fishery compared with the halibut and sablefish fishery, it is anticipated that the crab loan program may require fewer staff inputs.

Other effects of the captains and crew loan program on monitoring and enforcement

As an independent element of the BSAI crab rationalization program, the effects of the loan program for the captains and crew would be difficult to separate from the many other facets of Alternatives 2, 3, and 4. The principal effect of the loan program is anticipated to be an increase in the number of harvesting quota holders who were not eligible for initial distribution of QS. Average harvesting quota prices may increase modestly under the loan program if the magnitude of the subsidy on the loan is substantially larger than market rate available. Also, since the loan program would provide a comparative advantage (to acquire quota) to individuals who qualify for this program, and these individuals would generally not be the large scale quota holders, it is probable that QS would be distributed in a different manner than without the loan program. It is possible that an increase in these quota holding operations may result in slightly different fishing patterns.

4.6.7.5 Mandatory data collection for economic performance analysis

The Council has expressed considerable interest in assessing the economic effects of a new rationalization program because each alternative would fundamentally change the organization of crab fisheries and contain many new and unique features. The Council also understands that if a mechanism to collect economic data is not implemented along with the overall program, it is unlikely that the economic data needed to determine the impacts resulting from crab rationalization will ever be available to fisheries managers or the general public. To accomplish this assessment, provisions have been included in each rationalization program alternative to implement a mandatory data collection program that would ensure the necessary data are available to understand the impacts of the program. Each alternative rationalization program contains the same mandatory data collection program component.

The Magnuson-Stevens Act provides for collection of data that would benefit the development, implementation of, or revision of an FMP. For crab rationalization, the latter two objectives would be enhanced by the crab economic data collection program and provide data necessary to analysts and policy makers that are not typically available, despite executive orders, national standards, and other acts that encourage economic analysis of regulations.

The Magnuson-Stevens Act provides additional direction on data collection in: MSFCMA direction on data collection: 402. INFORMATION COLLECTION 7 16 U.S.C. 1881a

> (a) COUNCIL REQUESTS.--If a Council determines that additional information (other than information that would disclose proprietary or confidential commercial or financial information regarding fishing operations or fish processing operations) would be beneficial for developing, implementing, or revising a fishery management plan or for determining whether a fishery is in need of management, the Council may request that the Secretary implement an information collection program for the fishery which would provide the types of information (other than information that would disclose proprietary or confidential commercial or financial information regarding fishing operations or fish processing operations) specified by the Council.

Background on monitoring, management, and enforcement of the data collection program

The Council and its Scientific and Statistical Committee (SSC) have discussed the need for data to be collected under a mandatory economic data collection program for crab rationalization at several Council meetings between 2002 and 2003. At the June 2002 meeting, the Council voted on a preferred alternative for the crab rationalization program that outlined elements of a mandatory economic data collection program to assist in assessing the performance of the three-pie voluntary cooperative alternative. At that meeting, the Council also appointed an industry Data Collection Committee that was charged with developing proposals for further refining the program. In reviewing these proposals, the Council made adjustments to the mandatory data collection program in action taken at the October 2002, December 2002, and February 2003 meetings. For the February 2003 Council action, the Council staff drafted an analysis of the data collection program that addresses many components of the monitoring, management and enforcement issues, and contains a very complete effects analysis of the alternatives and implementation issues, including the monitoring, management, and enforcement of the data collection program (this analysis is in the RIR/IRFA in Appendix 1). This section provides additional monitoring, management, and enforcement implications of the data collection component.

June 2002 Council motion on data collection for crab rationalization

As stated in the June 2002 Council motion, point 14 states:

> The NPFMC and the NMFS shall have the authority to implement a mandatory data collection program of cost, revenue, ownership and employment data upon members of the BSAI crab fishing industry harvesting or processing fish under the Council's authority. Data collected under this authority will be maintained in a confidential manner and may not be released to any party other than staffs of federal and state agencies directly involved in the management of the fisheries under the Council's authority and their contractors.
>
> A mandatory data collection program shall be developed and implemented as part of the crab rationalization program and continued through the life of the program. Cost, revenue, ownership and employment data will be collected on a periodic basis (based on scientific requirements) to provide the information necessary to study the impacts of the crab rationalization program as well as collecting data that could be used to analyze the economic and social impacts of future FMP amendments on industry, regions, and localities. This data collection effort is also required to fulfill the Council problem statement requiring a crab rationalization program that would achieve "equity between the harvesting and processing sectors" and to monitor the "…economic stability for harvesters, processors and coastal communities." Both statutory and regulatory language shall be developed to ensure the confidentiality of these data.
>
> Any mandatory data collection program shall include:
>
> A comprehensive discussion of the enforcement of such a program, including enforcement actions that would be taken if inaccuracies in the data are found. The intent of this action would be to ensure that accurate data are collected without being overly burdensome on industry for unintended errors.

February 2003 Council motion on mandatory data collection for crab rationalization

The data collection text generated by the February 2003 Council motion states:

The mandatory data collection program shall have the following elements:

A. Purpose. The purpose of the data program is as set out in the June 2002 motion. The Council will require the production of data needed to assess the efficacy of the crab rationalization program and to determine its relative impact on fishery participants and communities.

B. Type of data to be collected. The data collected shall be that needed to achieve the Council's purpose, with the following general guidelines:
   1. The information will be specific to the crab fisheries included in the crab rationalization plan.
   2. The data shall include information on costs of fishing and processing, revenues for harvesters and processors, and employment data
   3. The general guide for information requirements will be as set out in the draft surveys prepared by NMFS dated 9/18/02, except
      a) Non-variable costs shall be collected only as needed to explain and analyze variable cost data.

b) Collect a unique identifier for harvesting and processing crew members to explain changes in participation patterns as requested by the AP.

4. Historical information will be required as recommended by the Data Collection Committee.

C. Method of Collection. Data shall be submitted to an independent third party agent such as the Pacific States Marine Fisheries Commission.

D. Use of data. Data will be used following these general guidelines:

1. Data shall be supplied to Agency users in a blind and unaggregated form;
2. The agencies will develop a protocol for the use of data, including controls on access to the data, rules for aggregation of data for release to the public, penalties for release of confidential data, and penalties for unauthorized use;
3. The agencies will revise the current Memorandum of Understanding governing the sharing of data between the State and NMFS, and will address in this MOU the role of the third party data collection agent;
4. The Agency and Council will promote development of additional legislative and regulatory protection for these data as needed.

E. Verification of Data. The third party collection agent shall verify the data in a manner that assures accuracy of the information supplied by private parties.

F. Enforcement of the data requirements. The Council endorses the approach to enforcing the data requirements developed by the staff and the Data Collection Committee, as set out on page 3.17-20 in the February, 2003 document entitled "BSAI Crab Rationalization Program, Trailing Amendments", which provides:

Anticipated Enforcement of the Data Collection Program

The analysts anticipate that enforcement of the data collection program will be different from enforcement programs used to ensure that accurate landings are reported. It is critical that landings data are reported in an accurate and timely manner, especially under an IFQ system, to properly monitor catch and remaining quota.

However, because it is unlikely that the economic data will be used for in-season management, it is anticipated that persons submitting the data will have an opportunity to correct omissions and errors before any enforcement action would be taken. Giving the person submitting data a chance to correct problems is considered important because of the complexities associated with generating these data. Only if the agency and the person submitting the data cannot reach a solution would the enforcement agency be contacted. The intent of this program is to ensure that accurate data are collected without being overly burdensome on industry for unintended errors.

A discussion of four scenarios will be presented to reflect the analysts understanding of how the enforcement program would function. The four scenarios are: 1) a case where no information is provided on a survey; 2) a case where partial information is provided; 3) a case where the agency has questions regarding the accuracy of the data that has been submitted; and 4) a case where a random "audit" to verify the data does not agree with data submitted in the survey.

In the first case, the person required to fill out the survey does not do so. In the second case, the person fills out some of the requested information, but the survey is incomplete. Under either case that person would be contacted by the agency collecting the data and asked to fulfill their obligation to provide the required information. If the problem is resolved and the requested data are provided, no other action would be taken. If that person does not comply with the request, the collecting agency would notify enforcement that the person is not complying with the requirement to provide the data. Enforcement would then use their discretion regarding the best method to achieve compliance. Those methods would likely include fines or loss of quota and could include criminal prosecution.

In the third case the person fills out all of the requested information, but the agency collecting the data, or the analysts using the data, have questions regarding some of the information provided. For example, this may occur when information provided by one company is much different than that provided by similar companies. These data would only be called into question when obvious differences are encountered. Should these cases arise, the agency collecting the data would request that the person providing the data double check the information. Any reporting errors could be corrected at that time. If the person submitting the data indicates that the data are accurate and the agency still has questions regarding the data, that firm's data could be "audited". It is anticipated that the review of data would be conducted by an accounting firm selected jointly by the agency and members of industry. Only when that firm refuses to comply with the collecting agencies attempts to verify the accuracy of the data would enforcement be contacted. Once contacted, enforcement would once again use their discretion on how to achieve compliance.

The fourth case would result when the "audit" reports different information than the survey. The "audit" procedure being contemplated is a verification protocol similar to that which was envisioned for use in the pollock data collection program developed by NMFS and Pacific States Marine Fisheries Commission (PSMFC). During the design of this process, input from certified public accountants was solicited in order to develop a verification process that is less costly and cumbersome than a typical "audit" procedure. That protocol involves using an accounting firm, agreed upon by the agency and industry, to conduct a random review of certain elements of the data provided."

"Since some of the information requested in the surveys may not be maintained by companies and must be calculated, it is possible that differences between the "audited" data from financial statements and survey data may arise. In that case the person filling out the survey would be asked to show how their numbers were derived (footnote 41). If their explanation resolves the problem, there would be no further action needed. If questions remained, the agency would continue to work with the providers of the data. Only when an impasse is reached would enforcement be called upon to resolve the issue. It is hoped that this system would help to prevent abuse of the verification and enforcement authority.

In summary, members of the crab industry will be contacted and given the opportunity to explain and/or correct any problems with the data, that are not willful and intentional attempts to mislead, before enforcement actions are taken. Agency staff does not view enforcement of this program as they would a quota monitoring program. Because these data are not being collected in "real" time, there is the opportunity to resolve occasional problems as part of the data collection system. Development of a program that collects the best information possible to conduct analyses of the crab rationalization program, minimizes the burden on industry, and minimizes the need for enforcement actions are the goals of the data collection initiative."

Identification of the "third party" data collection entity

For the purpose of ensuring confidentiality of the data, the mandatory data collection program requires a "third party" data collection agent. An example of such an agent, according to the motion, is Pacific State Marine Fisheries Commission (PSMFC). The PSMFC is a quasi-government agency that is funded under a grant to NOAA Fisheries, but does not report solely to a Regional Administrator. It consists of three offices: one in Portland, Oregon, one in Seattle, Washington, and one in Juneau, Alaska. The Juneau, Alaska, branch is called AKFIN. The mandatory data collection program makes the general assumption that the third-party agent will administer the collection, data capture, and dissemination of the economic data to Council, State staff, and NOAA Fisheries staff that are approved to use these data. It would be necessary to identify the agent's responsibilities for data collection, recordkeeping, auditing, maintenance of federal and State confidentiality and reporting responsibilities to NOAA Fisheries, the Council, and the State. .

General data collection responsibilities for the third party

The type of economic data to be collected include information on costs of fishing and processing, revenues for harvesters and processors, employment data, ownership data. The mandatory data collection program proposes restricting the collection of harvesting and processing cost data to only estimates of variable costs. Non-variable, or fixed costs, shall be collected only as needed to explain and analyze variable cost data. To the extent permitted by law, unique identifier data may be collected for harvesting and processing crew members to explain changes in participation patterns.

NOAA Fisheries anticipates that all the data collection responsibilities would be specified in regulation within a separate record keeping rule for crab rationalization.

Method of collection undertaken by the third party and collection instruments

The AFSC would develop the surveys along with harvesters and processors participating in the industry committee on data collection. Other data useful for economic analysis, in general, and specifically for assessing the crab rationalization program performance would also be accessed from existing sources. Other sources of data include the Commercial Operator's Annual Report, crab quota share permit applications and fish tickets from ADF&G.

Verification of data including auditing and error checking

The mandatory data collection program provides that verification of data, auditing, and error checking would be the primary responsibility of the third party agent. Consistent with procedures set forth in the motion, the agent will be obligated to develop an appropriate system for identifying outliers, incomplete data, or anomalies in the data submissions. Further, the third party agent will be obligated to retain qualified professional analysts or accountants to review data submissions and identify errors or flag possible fraudulent submissions.

Use of data by managing agencies and data confidentiality

It is anticipated that NOAA Fisheries, the State, and Council staff would have frequent data requests for creation of custom data sets to be supplied by PSMFC. The procedure for creating custom data sets would involve considerable agency and PSMFC coordination to generate a data set with the information variables required for the reviews of the program's efficacy and environmental effects.

The data collection program would require regulations and some changes in the enforcement of these more stringent standards for federal and State staff. The analysis in the RIR/IRFA, in Appendix 1, does not discuss any examples of confidentiality standards more stringent than those found in existing regulations. Discussions within the Data Collection Committee suggest that the agencies using the data should have a formal tracking system that identifies which employees use this data, for what purposes the data are being used, and to whom the ultimate work products are released. Such a system would result in some changes to current practices and additional tracking burden on NOAA Fisheries, Council staff, and the State. This tracking could be augmented by more serious civil or criminal penalties to those that are not using the confidential data for the intended purposes. The Council has not specified what these penalties may be, and it is assumed that there would be no new policies or regulations regarding stiffer agency action to be taken in the event of improper disclosure.

The data collection program would require regulations and some changes in the enforcement of these more stringent standards for federal and State staff. The analysis in the RIR/IRFA, in Appendix 1, does not discuss any examples of confidentiality standards more stringent than those found in existing regulations. Discussions within the Data Collection Committee suggest that the agencies using the data should have a formal tracking system that identifies which employees use this data, for what purposes the data are being used, and to whom the ultimate work products are released. Such a system would result in some changes to current practices and additional tracking burden on NOAA Fisheries, Council staff, and the State. This tracking could be augmented by more serious civil or criminal penalties to those that are not using the confidential data for the intended purposes. The Council has not specified what these penalties may be, and it is assumed that there would be no new policies or regulations regarding stiffer agency action to be taken in the event of improper disclosure.

The data collection program is considered to be a Category 1 action under the FMP may potentially cause some duplication with existing State data collection. The potential overlap, requires careful coordination with ADF&G.

Other effects related to the analysis of the performance of the crab rationalization program

In general, it would be nearly impossible to project how the use of data collection aimed at evaluating the performance of the program could impact the prosecution of fisheries or the environment. However, it is likely that these data will be used to analyze whether certain economic objectives of the program are being achieved, and thus may indirectly provide an impetus for further modifications of the program. For example, if the data reveals that previously unanticipated distributional impacts occur or efficiency objectives are not met, such findings may be a conduit for initiating further mitigative actions. Changes to the program that are linked to findings associated with analyses of these data will likely differ according to the ways in which the fishery is affected. Therefore, the nature of these potential effects are simply impossible to predict.

Enforcement of the data requirements and confidentiality

While blind data will be provided to NMFS, the State of Alaska and any other entities authorized to receive the economic data, identifiers for the data will be release with the corresponding data for purposes of enforcement, determinations by DOJ or FTC regarding anti-trust and establishing eligibility for quota share. The third party agent would be authorized to release data and corresponding identifiers to RAM, NOAA enforcement, NOAA GC, DOJ, and the FTC.

The mandatory data collection program provides outlines a process for enforcing the collection of data, however, this may not be included in either FMP or regulatory language. The program allows a data submitter opportunity to review and correct potential data errors before the third party would notify NOAA Fisheries of any non-compliance. In some instances, data will be audited for accuracy and the submitter would participate in the audit. This auditing function would place much of the monitoring burden on the third party agency because the third party agent will retain the auditor and control the audit process (suggested by the Council to be the PSMFC). Yet the auditing trail would need to be carefully documented for data collection if any non-response referrals were made to NOAA Fisheries or NOAA Fisheries Enforcement. This would impose costs on the third party agent and raise issues regarding whether a third party governmental entity can be relied upon to supply compliance data that would be usable in court. To produce a highly enforceable data collection system, it would be necessary for NOAA Fisheries Enforcement to have access to all economic data collected, including individual identifiers. The assumption that all data would be subject to review, and potentially intentional misreporting of data subject to enforcement action, may impose additional reporting costs on business entities.

Establishing the reporting period and industry burden

While the mandatory data collection program does not specify a date for delivery of data to the third party[4], it is assumed that a date certain for supplying annual data would be included in regulation. It would be difficult to enforce an open-ended period for data collection from crab harvesters and processors. Judging from draft surveys developed by the Data Collection Committee and the AFSC, the quantity of data to be collected from the crab industry is not trivial. As part of the recordkeeping and reporting regulations that would either accompany the program or follow the final rule, the probable burden imposed on businesses would be addressed. These reporting requirements may involve an annual reporting exercise that would be equivalent to completing a modest federal income tax form for a small business. Much of this economic data is anticipated to be assembled by these entities for other business purposes, yet the transcribing of the data would involve some costs.

Resource agency costs of the data collection program

PSMFC staff estimates that the data collection program may require three full-time staff persons, depending on many variables including the location of the office.

[4]During the Committee meetings this issue was discussed at some length. It was generally agreed that because these data are not needed for in-season management of the fisheries, it would not need to be collected while the fishery takes place. Some members of the Committee felt that the data should not be required until at least three months after the close of the fishery. The three month time lag was also deemed to be acceptable by agency staff.

4.6.8 Effects of the alternatives on other State fisheries

The State manages all crab fisheries (FMP and non-FMP) in the BSAI. Within 3-miles, State biologists manage salmon, herring, scallops, and groundfish fisheries. Additionally, the State manages black and blue rockfish to 200 nm in the GOA. ADF&G provided the following analysis on the effects of the alternatives in other State fisheries.

Salmon fisheries along the Alaska Peninsula and Aleutian Islands have taken place for many thousands of years by the area's indigenous people. Commercial fisheries have taken place for over 100 years. All salmon fisheries in Alaska now operate on a limited entry system in place since the mid-1970's. Since then, fisheries have been restricted to using purse seine, drift gillnet, and setnet gear. The Alaska Peninsula (north and south sides) supports approximately 121 purse seine permits (75 fished on average 1997-2001), 160 drift gillnet permits (154 fished on average 1997-2001), and 113 setnet permits (107 fished on average 1997-2001). Salmon fisheries in the area are worth approximately $6.4 million to the setnet fleet, $6.9 million to the purse seine fleet, and $13.2 million to the drift gillnet fleet each year (average 1996-2000). The Aleutian Islands (Atka/Amlia) setnet fishery supports a handful of local fishermen (four permits issued on average 1997-2001), although there has been no fishery due to a lack of buyers/markets since the 1996 season. Crab rationalization should have little impact on salmon fisheries other than possible processing line conflicts under relaxed crab season guidelines, and the possibility of new money becoming available to purchase salmon vessels or permits. Though this seems unlikely given low values paid for salmon and declining permit values for salmon limited entry permits – most salmon fishermen are seeking diversification in order to continue to remain solvent.

Herring fisheries for roe or food and bait occur in the area using purse seine and gillnet gear. There are approximately 34 purse seiners and 9 gillnetters (average 1997-2001) that participate in the Alaska Peninsula sac roe fisheries, but there has been no commercial fishery since 1996 due to lack of markets. In the food and bait fishery, approximately 21 purse seiners and two gillnetters (average 1997-2001) have taken part in that fishery. That fishery is worth approximately $900,000 annually (average 1996-2000). Herring fisheries in the area do not operate on a limited entry system. Because there is no moratorium, new operators could enter the fishery increasing competition on a limited resource. However, given the condition of recent herring markets, this is unlikely to occur.

Groundfish fisheries under jurisdiction of the State occur for rockfish, lingcod, sablefish, and Pacific cod. None of these fisheries operate under a limited entry or moratorium system so displaced or idled crab vessels could move into these fisheries, if there was an economical advantage. Also, if rationalization were to provide increased revenues to crabbers or processing plants, that money could find its way into these fisheries in the form of new vessels or the purchase of existing industry C/P power. Past participation in these groundfish fisheries, including those that parallel the federally managed fishery within State waters, has involved between 500-600 vessels, most in Kodiak area Pacific cod fisheries. However, far fewer vessels participate in fisheries actively managed by the State (i.e., black rockfish, State-water Pacific cod, western Aleutian Islands sablefish, and lingcod).

Pacific cod fishing under State management within State waters in the Westward Region is limited to vessels using jig or pot gear outside the parallel season. During the parallel season, trawl and longline gear are also permitted. Current regulations in some areas place some limitations on vessels larger than 58 feet LOA involved in Pacific cod fisheries. These include area vessel size limit restrictions in the Chignik and South Alaska Peninsula waters, and harvest allocations in the Kodiak area (vessels over 58 feet LOA are limited to 25 percent of the GHL for pot gear prior to September 1, after which the Commissioner of ADF&G may rescind the restriction based on vessel length).

For the Bering Sea, rockfish and lingcod catches are under half a million pounds by approximately 120 vessels, most taken in the Kodiak area. GHLs for black rockfish in Chignik and the South Alaska Peninsula are 100,000 pounds annually. There are approximately 15 vessels that direct their effort on black rockfish, while the remaining vessels have harvested black rockfish as bycatch incidental to other fisheries. Crab vessels no longer active in crab fisheries because of coop formations could seek to move into fisheries for these species, although potential earnings have generally kept this a small boat fleet.

Sablefish in State waters are managed separately from the federal IFQ program. Habitat for mature sablefish is extremely limited in Westward Region State waters. These fish generally prefer deeper waters of the continental slope. Stocks are not abundant in Kodiak, Chignik, and the eastern district of the South Alaska Peninsula areas. A directed fishery in these management areas was closed by regulation by the Board in January 2002. A 1 percent bycatch has been allowed in other fisheries; this allocation is managed by NOAA Fisheries in both State and federal waters. A fishery in the western district of the South Alaska Peninsula is managed as part of an Aleutian Islands State water fishery. The 2000 harvest of sablefish taken as bycatch from State waters in the three areas totaled about 20 mt. Movement could occur from the crab fleet to the sablefish fleet after refitting crab vessels to fish with longlines, if this proved economically feasible.

Other species of groundfish harvested in State waters during federally-managed fisheries include Atka mackerel, Pacific Ocean perch, dusky rockfish, flathead sole, arrowtooth flounder, yellowfin sole, rock sole, English sole, and various skate species. These fish are primarily taken by trawl fisheries but occasionally are incidentally captured by other gear types. A total of 1.3 million pounds (610 mt) of miscellaneous groundfish species were landed from State waters in the Kodiak, Chignik, and South Alaska Peninsula areas during 2000. Exploitation of skates and flatfish has been limited primarily because non-pelagic trawls are prohibited in most State waters and longline halibut bycatch allowances are taken up by the Pacific cod fishery. Other harvest methods have not proved economically effective.

Possible impacts to these groundfish fisheries due to crab rationalization are not known. Vessel size restrictions and gear limitations for some fisheries could limit impacts from displaced crab vessels as well as those freed up by co-op formations.

Crab fisheries outside proposed rationalization could also be subject to increased effort. These would include those fisheries for Tanner crab, dungeness crab, deep-water king and Tanner crab, as well as Korean Hair crab.

Although the Kodiak Tanner crab district is super-exclusive, there is no vessel size limit or limited-entry at this time. Idled vessels from the Bering Sea fisheries could certainly engage in this fishery. While this fishery operated many years ago, it has only recently recovered to a level where surplus is once again harvestable. Area fishermen went before the Board and received a designation of the area as super-exclusive. The Board also adopted restrictive pot limits (30 pots) that have been used to reduce efficiency and allow proper management of surplus male crab, but increased fishing effort would require further assessment of the resource's potential.

The 1996-2000 five-year-average value for Dungeness crab in the Westward Region is just over $1 million. The average number of vessels fishing during this period is approximately 16. The vast majority of these crab are from Kodiak area waters and involve vessels under 60 feet LOA. This fishery is under no limited entry or moratorium program at this time, but the size of this fishery is not likely to attract new entrants.

Deep-water king crab fisheries in the Bering Sea are conducted under terms of a Commissioner's Permit from the ADF&G. Scarlet king crab (*Lithodes couesi*) catches primarily occur as bycatch in the grooved Tanner crab (*Chionoecetes tanneri*) and golden king crab fisheries. In waters outside of the Aleutian Islands area, no vessels have registered to fish scarlet king crab since 1997. In the Aleutian Islands area, approximately four vessels have fished per year for the past several years. The State could limit involvement through a close assessment of the permitting process if increased interest was shown in this fishery.

Fisheries for two species of deep-water Tanner crab occur in the Bering Sea; they target grooved Tanner crab and bycatch triangle Tanner (*Chionoecetes angulatus*) crab. As in the case of deep-water king crab, little or no interest in these species has been shown for years. These fisheries also operate under the authority of a Commissioner's Permit. Renewed interest in these species as a result of crab rationalization would increase scrutiny in permits issued.

Korean Hair crab fisheries have been operating under a moratorium since 1996, and in 2002 the Alaska State Legislature adopted language to create a vessel license limited entry system for this fishery. Therefore no new vessels could move into this fishery. The Commercial Fisheries Entry Commission is in the process of determining the exact number of vessels meeting qualifying requirements (24 or 25). They will then perform an analysis to determine the optimum number to be permitted to participate in this fishery. Historically, about twelve hair crab vessels have shown recent reliance on this resource. The Council's preferred alternative for crab rationalization (adopted at the June 2002 meeting) has language for a trailing amendment to consider sideboards. A suboption in that sideboard language directs Council staff to analyze economic dependency on the Korean Hair crab resource in the Bering Sea. This fishery has a 1996-2000 five-year average ex-vessel value of just over one million dollars to active participants; although in the early 1990's it was worth five times that amount to 19 fishermen. Because some of the permit holders are crab fishermen who will receive QS, the rationalization program under Alternative 2 may entice participation.

Miscellaneous shellfish species would include weathervane scallops, shrimp, sea urchins, sea cucumbers, octopus, snails, and surf clams. Scallop fisheries operate under FMP and State management. For scallops, there is a State and federal vessel LLP. Therefore, no new entrants from the crab fleet would be allowed to participate.

Shrimp fisheries in the area are under an open access system but operate under a specific management plan outlined in regulations by the Board. Many areas around Kodiak and Chignik remain closed. Efforts in the Aleutian Islands area are limited to less than six vessels over the period of the last few years. However, this fishery was worth between one half and one million dollars, annually, to fishermen through the early 1980's. Currently, shrimp populations are below thresholds established for commercial fishery openings, but should stocks rebuild, increased participation should be monitored. There is also the potential for a Bering Sea shrimp fishery. In the late 1990's, a few factory trawlers harvested significant poundage from that area.

Dive fisheries for sea urchins and sea cucumbers operate under terms of a Commissioner's Permit with established GHLs for each section. These range from 30,000 pounds to 5,000 pounds. Areas with no historic harvest data have a conservative 5,000 pound GHL to allow for exploration. All weights represent eviscerated product for sea cucumbers and whole animal weights for sea urchins. The GHLs were established to permit conservative commercial exploitation of areas that lacked historic harvest data and to allow the ADF&G to collect critical information for future management purposes. While vessels freed up through organization of fishery cooperatives could enter this fishery, or monies earned through sale of crab IFQ could allow ownership of dive boats and operations to change, existing caps and permit requirements might make entering into this fishery less desirable. ADF&G would continue to manage the resource in this manner and assess changes in participation levels, which have been low since the development of these fisheries.

The last directed commercial fishery for BSAI octopus occurred in 1995. Less than three vessels made landings, therefore the harvest information is confidential. Since 1995, all reported harvests in the Bering Sea have been incidental bycatch. Currently, directed fishing for octopus is not permitted in the Bering Sea district.

The Bering Sea snail fisheries began with the Japanese in 1971 and continued until 1987. The majority of the retained catch during this early fishery was composed of the Pribilof Neptune snail (*Neptunea pribiloffensis*). Smaller components of the retained catch were composed of *Buccinum angulossum* and *B. scalariforme*. The U.S. snail fishery began in 1992. Observer coverage was required as a condition of the Commissioner's Permit issued in 1993 under 5 AAC 39.210(h) MANAGEMENT PLAN FOR HIGH IMPACT EMERGING FISHERIES. Ex-vessel value increased to a peak value of $1.1 million in 1996. There has been no interest or effort in this fishery since 1997. Any renewed interest in these species as a result of crab rationalization would increase scrutiny by the ADF&G in permits issued.

Rationalization of the BSAI crab fisheries could also create a potential interest in a surf clam fishery. This resource has provoked repeated interest by fishermen in the past. Rationalization could provide a stable income, which would enhance an owner's ability to finance speculative ventures. This could put pressure on species not currently targeted by large scale fisheries, i.e., shrimp, snails, octopus, flatfish with pot gear, and surf clams.

Likewise, Alterative 3 could shift the effort from the crab fisheries into other fisheries and increase capitalization in those fisheries. This could result in additional management measures for these fisheries to protect them from overharvest and protect the long-time participants.

4.6.9 Effects on vessel safety

This analysis will examine the incentives for risking participant and vessel safety under the different alternatives. Management programs can create incentives for fishermen to risk vessels and lives. These incentives exist in a derby-style fishery (such as Alternative 1), as vessel owners and captains, in an attempt to maximize their share of the harvest in a limited time frame, are more pressured to fish in dangerous weather, fish round the clock, and overload their vessel with gear. On the other hand, management measures designed to remove the race to fish, and allow fishermen the opportunity to make choices on when and where to fish should theoretically improve vessel safety. Among the arguments put forth for rationalization of the crab fisheries is that it could improve safety in the fishery by reducing the incentives to fish in dangerous weather and take risks.

Safety is a primary and often-cited concern for captains and crews in the BSAI crab fisheries. Casualties, discussed below, corroborate that such concerns are valid. Under Alternative 1, the fisheries occur primarily in the winter, when weather conditions can be dangerous. Winds in excess of 60 knots accompanied with heavy seas and freezing rain, sleet, and/or snow are common. The stacking of crab pots on deck, coupled with icing, can greatly reduce a vessel's stability.

Between 1990 and 2001, 61 fatalities occurred and 25 vessels were lost in the BSAI crab fisheries (Table 4.6-19). Most fatalities in the fisheries were related to vessel losses; from 1990 to 2001, a total of 10 vessel losses resulted in 40 fatalities. The other 11 vessel losses in the fishery occurred without fatalities. Twenty-one fatalities, unrelated to vessel loss, were the result of fishermen being swept overboard, crushed by crab pots, or entangled in winches or other equipment. The single largest number of fatalities occurred during the 1991 fishing season when 12 fishermen were killed, followed by 10 fatalities in 1992.

Table 4.6-19 Number of fatalities and vessel losses for the Bering Sea and Aleutian Islands crab fishery from 1990 to 2001.

Year	*Deck Fatalities*	*Vessel Lost Fatalities*	*Total Fatalities*	*Total Vessels Lost*
1990	2	0	2	3
1991	4	8	12	2
1992	4	6	10	2
1993	2	5	7	2
1994	1	1	2	6
1995	0	7	7	4
1996	2	7	9	3
1997	0	1	1	1
1998	3	0	3	0
1999	2	5	7	2
2000	0	0	0	0
2001	1	0	1	0
Total	21	40	61	25

National Institute of Occupational Safety and Health studies conducted in 1997 and 2001 found that the Alaskan commercial fishing industry had a fatality rate 28 times the national occupational average. Within this high-risk industry, the BSAI crab fisheries were found to account for a disproportionately high level of injuries and deaths. From 1991 to 1998, crab sector fishermen represented 13 percent of total worker effort in Alaska fisheries, but suffered 46 percent of the industry fatalities and 38 percent of the industry injuries. In recent years, the number of fatalities related to vessel losses has declined significantly. During the past four years, only one vessel has been lost. That loss, however, resulted in five fatalities. Although losses and fatalities in the fisheries have declined in recent years, it is important to note that these statistics are not normalized for either the number of fishery participants or total fishing effort. Some of the decline may be attributed to the reduction in fishing effort, caused by the significant reduction in some crab GHLs.

Some of the improvement in safety statistics may also be attributed to improved safety standards adopted under the Commercial Fishing Industry Vessel Safety Act of 1988. This law requires most commercial fishing vessels to carry safety equipment such as survival suits, life rafts, and electronic position indicating radio beacons.

Potential effect of Alternatives 2, 3, and 4 on safety

Changing the way the fishery is conducted has the potential to improve safety conditions. Under the current management scheme for the BSAI crab fisheries, each individual vessel owner or captain has an incentive to maximize his/her share of the GHL in an environment of open competition. This results in a derby-style race for fish, where participants feel pressured to fish in unsafe weather conditions, work continuously for long periods without rest, and potentially overload their vessels in an attempt to improve returns. Falling GHLs in some crab fisheries has reduced the length of the seasons, thus exacerbating the problem.

Implementing an IFQ, PQ, or cooperative management regime would change the incentives for fishermen. The incentive to race for fish would be eliminated if each vessel had a pre-determined share of the catch. Owners and captains would presumably be less pressured to expose crews to unsafe conditions, more likely to take weather into account when deciding whether to go out, and less likely to take a vessel fishing without first completing needed repairs. Consequently, fatalities might be reduced.

Another potential beneficial effect of IFQ management is that to the extent that a rationalized management system results in a more sustainable, economically viable fishery, then improvements in safety should follow. In sustainable and economically viable fisheries, harvesters are able to make a profit, and vessel owners are able to invest in sound equipment, maintain their equipment properly, and hire, train, and keep professional captains and crews. All of these factors help improve vessel safety.

Additionally, under the current management regime, processing facilities operate 24 hours a day to process all of the crab at once at the close of the season because crab must be processed alive. Under the rationalization alternatives, safety at processing facilities may also improve by removing these time pressures.

Alternative 2 involves a system of QS for processors as well as harvesters. It has been suggested that an excessive consolidation of processor shares may result in a situation where vessel owners or captains have less autonomy to take weather into account when deciding when to fish, possibly mitigating the benefits of an IFQ management program in terms of safety. Provisions of Alternative 2, including caps on consolidation of processor shares, the 10 percent of PQ left open to competition, and the guarantee of regional distribution of PQ, could all work to partially or completely prevent this problem from materializing.

Certain features with potential safety ramifications can be built into a rights-based management system. These include requirements that the QS holder be onboard the vessel when the quota is fished, and that QS holders show some level of fishing experience before being allowed to buy into the fishery. An argument can be made that these requirements might have a safety dividend by ensuring that quota holders remain closely connected to the fishing operation and have a fundamental interest in the safe conduct of the fishery. These requirements would also ensure the fishery does not evolve into one owned by entities that have no fishing background. Given that BSAI crab fisheries are largely prosecuted with hired captains and crews and occur without owner-onboard participation, such provisions may not be appropriate for these fisheries.

Both of above mentioned elements related to quota holders were written into the halibut and sablefish IFQ system. As discussed later, there is no hard data from the halibut and sablefish fisheries to back up the theoretical advantage of these requirements in terms of safety. It should be noted that even in a case where owner-onboard provisions are made part of a management program, any potential safety dividend might be reduced by the existence of a grandfather exemption for those issued initial QS. In the case of the halibut and sablefish fisheries, such an exemption was given to initial QS holders, and all A class quota holders. As a result, in the year 2001, seven years after the implementation of the IFQ system, 41 percent of all halibut and 55 percent of all sablefish caught in Alaska by hired captains.

Have individual fishing quotas improved safety elsewhere?

It might be useful to examine what has happened in other fisheries that have adopted IFQs to test the assumption that IFQ management improves safety. A National Research Council (NRC) study of IQs worldwide[1] researched this issue and concluded: "Although empirical evidence suggests that safety has improved in some IFQ-managed fisheries, it is not clear that safety has improved in all fisheries managed using IFQs" (NRC 1999). The study reported that even data on changes in safety for fisheries tends to be anecdotal, but that fishermen generally report feeling "less constrained to fish in bad weather." The NRC concluded that "IFQs could be used in a preventive manner . . . to remedy existing incentives to fish under dangerous conditions" (NRC 1999).

Alaskan halibut and sablefish fisheries

One of the 10 stated objectives of the halibut and sablefish IFQ program was to improve safety (NPFMC 1991). Safety statistics in the Alaskan halibut and sablefish fisheries would seem to indicate that safety has improved since implementation of the IFQ system there, although it is not possible to say precisely what factors were responsible. In the five years preceding implementation of the IFQ program (1990 to 1994), 17 fatalities occurred in the halibut and sablefish fisheries. In the seven years after implementation of the program (1995 to 2001), the number of fatalities in the fisheries declined to four.

Other changes include a move to an IFQ system that has greatly changed many aspects of the fisheries, such as the number of vessels participating, number of crewmen employed on each vessel, length of fishing seasons, etc. The following statistics provide examples of how the fishery has changed under the IFQ system. Since the inception of the IFQ system, the number of vessels fishing for halibut has been reduced by 58 percent (3,450 to 1,451) and the number of persons holding quota has been reduced by 27 percent (4,828 to 3,532). There has also been significant new entries into the fishery; 975, or 28 percent of current QS holders have bought into the fishery, and these participants fished 20 percent of the total TAC in 2001. Additionally, the pace of the halibut fishery has slowed, from two or three 24-48 hour openings in the late spring and/or early fall of each year, to an 8-month season.

Whether, or to what extent, the specific factor of eliminating the race for fish, and thereby allowing for more flexible decisions on when to fish, is responsible for the improved safety record is harder to pin down. The statistics would have to be normalized for fishing effort, expressed in units such as fishing vessel trip-days, person-hours fished, etc. These data are not currently available, and even if they were, it would be impossible to isolate this factor from the others. It is easier to say that all changed aspects of the fishery taken together seem to have improved safety, unless the improvement is simply a coincidence.

The annual average number of search and rescue missions conducted by the U.S. Coast Guard in Alaska's halibut and sablefish fisheries decreased significantly ($p=0.009$) and substantially, about 63 percent, following implementation of IFQs in Alaska (Table 4.6-20). Expenditures for search and rescue operations have been reduced accordingly.

[1] This report was produced under a legislative mandate from the Sustainable Fisheries Act of 1996.

Table 4.6-20 Search and rescue statistics from Alaskan halibut and sablefish individual fishing quota fisheries.

Year	Number of Search and Rescue Cases	Mortalities
1992	24	5
1993	26	0
1994	33	1
IFQs Implemented		
1995	15	0
1996	7	2
1997	9	1
1998	9	1
1999	6	1
2000	3	0
2001	7	0

Notes: IFQ - individual fishing quota.
Source: U.S. Coast Guard

New England clam/ocean quahog fishery

An ITQ system was implemented in the New England/Ocean Quahog Fishery in 1990. One of the main selling points of the ITQ program was its potential to improve safety through reducing the size of the fleet, removing older vessels, and removing pressures to fish in unsafe ways (McCay 1992). However, the rate of loss before and after ITQs went into effect is comparable. During the 1980's, an average of one boat a year was lost. At least 14 lives have been lost since implementation of the program; two clam vessels sank in the two years after the program went into effect; one vessel was lost in 1997 and five in 1999. Some critics of the surf clam ITQ system have suggested that the ITQ system is responsible for increased deaths. People interviewed after the first two vessels sank said that ITQs did not help because the processors were demanding that vessels fish when the product was needed, even if the weather was bad (Beal 1992; McCay and Creed 1994). According to James O'Malley, Director of the East Coast Fisheries Federation:

> ITQs have been advocated as a way of improving vessel safety, supposedly because they can put a stop to derby fisheries and give fishermen choices about when and how to fish. But the surf clam fishery lost at least 18 men in its first decade under ITQ management. That's about 10 percent of the entire workforce. That's a staggering number, and it's the most dangerous fishery in the world. We need to find out whether ITQs might have had anything to do with that, by changing the nature of the relationship between fisherman and buyer, or fisherman and ITQ-holder. Are fishermen now exposed to other dangers, fewer choices, because of a shift in the balance of power in the industry?[1]

This viewpoint is disputed by others who feel these accidents were an aberration and that safety has improved. Tom Hoff of the Mid-Atlantic Fisheries Management Council challenges the notion that processors have more power than before the ITQ system went into effect, and that the management structure hurts safety. Hoff points out that under the previous time management system, fishermen were tied to a predetermined individual schedule and lost their right to fish if they did not go out on the

[1] http://www.lobsterconservation.com/surfclam/

appointed day. Hoff also indicates that two of the vessels lost recently were overloaded with cages and, in one case, a crew member fell asleep at the wheel. A U.S. Coast Guard report on accidents in the clam fishery faults weak safety standards, and concludes that the conditions common to many of the casualties were poor vessel or equipment condition, inadequate training to respond to emergencies and use survival gear, and lack of awareness or ignoring of stability issues (U.S. Coast Guard 1999). The report states that safety statistics had improved somewhat, if the five years before and after enactment of the Commercial Fishing Industry Vessel Safety Act of 1988 are compared. “Though tragic and shocking,” says the report, “the recent loss (December 1998 and January 1999) of eleven lives and four clam and conch fishing boats is not a departure from historical casualty rates. Comparing this period to the overall loss rates of the past four years shows no significant shift in casualty statistics.”

In light of the statistics, the question about whether ITQs have enhanced or mitigated the risks in the surf clam/ocean quahog fishery remains unanswered (NRC 1999)

Iceland

In Iceland, which instituted one of the earliest ITQ systems in 1986, there were 132 fatal accidents at sea between 1966 and 1986; 108 of these were drownings, resulting in a mortality rate of 89.4 per 100,000 person-years (Rafnsson and Gunnarssdóttir 1992). This rate has not changed appreciably during the ITQ period. The impact of the ITQ system on safety is difficult to evaluate for reasons similar to those which make it difficult to evaluate the Alaska halibut system: many aspects of the fishery have changed, including the structure of the fleet and the number of fishermen; new safety regulations have been introduced which themselves could be affecting the outcome; and there has been no systematic study of the effect of ITQs on safety.

Conclusion

Instituting a rights-based program in the Alaska crab fisheries would likely achieve similar results to those in other ITQ systems worldwide. Effort would be consolidated, a shift in allocation among the participants would occur, and the fishing season would be lengthened. The resulting effect on fishing vessel safety of the combined force of these changes cannot be predicted with any precision. What can be predicted is that the effect of a slower-paced, more economically viable fishery, where vessel owners can invest in and captains can operate with safe vessels and professional crews, and where captains are empowered to take weather better into account when deciding when to fish should be positive with respect to safety. Therefore, NOAA Fisheries concludes that Alternatives 2, 3, and 4 would have a significantly positive effect on vessel safety. Additionally, under Alternatives 2, 3, and 4, safety at processing facilities may also improve by removing time pressures.

4.6.10 Scientific, cultural, or historical resources

The Council on Environmental Quality regulations (at 1508.27(b)(8)) for implementing NEPA require the EIS analyze whether the proposed action may effect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historic resources. Due to the nature of the action, to rationalize the BSAI crab fisheries, this action will have no effect on districts, sites, highways, structures, or objects listed in or eligible for the National Register of Historic Places or cause loss or destruction of significant scientific, cultural, or historic resources.

4.7 Environmental justice considerations

Concerns regarding environmental equity are generally termed "environmental justice." Environmental justice can also be defined as "the determination of equal justice and equal protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, and/or socioeconomic status" (Bryant 2001). Environmental justice issues encompass a broad range of impacts including those on the natural and physical environment and related social, cultural, and economic effects. Executive Order 12898 (Environmental Justice, 59 Fed. Reg. 7629 [1994]) requires each federal agency to achieve environmental justice by addressing "disproportionately high and adverse human health and environmental effects on minority and low-income populations."

4.7.1 Environmental justice existing conditions

To determine whether environmental justice concerns exist, the demographics of the relevant area are examined to determine whether minority populations or low-income populations are present and could experience disproportionate impacts from the proposed alternatives. The question as to whether a proposed alternative raises environmental justice issues depends to a large degree on the history or circumstances of a particular community or population, as well as the specific ties of that community or population to the resources (or access to resources) that will be changed by the alternative.

4.7.1.1 Approach

There is no standardized methodology for identification or analysis of environmental justice issues. The demographics of the affected area should be examined to determine whether minority populations, low income populations are present if so, a determination must be made as to whether the implementation of the alternatives may cause disproportionately high and adverse human health or environmental effects on the minority populations, or low-income populations present.

In determining what constitutes a low-income or minority "population" CEQ guidance, with specific regard to minority populations states: "if the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis." While no available federal guidance addresses the determination of low-income populations, a similar approach has generally been adopted when preparing NEPA documents (King 2001). The U.S. EPA has stated that addressing environmental justice concerns is entirely consistent with NEPA and that disproportionately high and adverse human health or environmental effects on minority or low-income populations should be analyzed with the same tools currently intrinsic to the NEPA process. NOAA environmental review procedures[1] state that, unlike NEPA, the trigger for analysis under Executive Order 12898 is not limited to actions that are major or significant, and hence federal agencies are mandated to identify and address, as appropriate "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

[1] NOAA Environmental Review Procedures for Implementing the National Environmental Policy Act (Issued 06/03/99).

4.7.1.2 Community variations and data limitations

The population structure of the communities and regions engaged in the BSAI crab fishery vary considerably. As discussed below and elaborated in Appendix 3, within the relevant coastal Alaskan communities there is a relationship between the percentage of Alaska Native population and commercial fisheries development. Specifically, communities that have developed as large commercial fishing communities in the BSAI region have become less Native in composition over time compared to other communities in the region. There are many variables involved, but for most communities noted the relationship is quite straightforward. The fishery has also had an impact on the male-female population balance for some of the Alaskan communities that are the focus of intensive crab processing. This is because processing workers reside within these communities for varying durations, and this workforce is predominately male. While this type of direct impact on population structure attributable to crab and other commercial fisheries is seen in few communities, these tend to be the communities with the highest level of crab-related processing activities and the highest engagement in, and dependence upon, the fishery. An exception to this generalization is St. Paul, where intense processing activity takes place, but where much of the processing-associated employment is found aboard mobile processors, such that the employees typically do not show up in local population counts. The differences in the male/female and Native/non-Native population segments are, to a degree, indicative of the type of articulation of the directly fishery-related population with the rest of the community.

Interpretation of these data, in terms of engagement with the community, is less straightforward for some communities or regions than for others. As detailed in Section 3.4.4, and in the community profiles in Appendix 3, communities are engaged in, and dependent upon, the fishery in quite different ways through resident CV fleets, onshore processing facilities, and locally associated floating or C/P entities. While no consistent data are available, field observations indicate that ownership and crew demographics of the residential CV fleet for the relevant Alaska crab communities tend to mirror the community demographics at large. This situation also appears to hold true for the smaller C/P vessels based in Alaska communities, but the larger vessel C/P and floating processor vessels are to a large degree associated with the Washington region, and crews tend to be drawn from a wide area rather than a particular community. These factors are discussed in a separate section below. For the large processing plants that utilize crab, the demographics of the workforce and the relation to the "host" communities tend to be more complex and have substantial environmental justice implications.

In some Alaska crab communities, processing plants tend to be industrial enclaves somewhat separate from the rest of the community, while for others there is no apparent differentiation between the processing workforce and the rest of the regional or local labor pool. A further complication for attribution of socioeconomic impacts to a local community or regional base is the fact that for many workers in many of the sectors, crab-related work is performed in a region or community that is separate from where they have a number of other socioeconomic ties. It is not uncommon for fishery-related workers to spend relatively little money in their work region and to send pay 'home' to another community or region. In this sense, regional employment is indicative of a volume of economic activity, if not a specific level of labor activity directly comparable to other industries. The importance of this flow varies from region to region and from sector to sector, but it is most apparent within communities that are most heavily engaged in the processing aspect of the crab fishery.

For the purposes of this environmental justice analysis, however, these populations will be characterized as being resident in their workplace communities, consistent with U.S. Census methodology. One of the current limitations of U.S. Census data, however, is that not all of the 2000 data relevant to this environmental justice analysis have been released. Ethnicity by housing type (e.g., by ethnicity by group quarters and non-group quarters), particularly useful for examining resident processing workforce numbers in Alaska coastal communities for this analysis, is not available, so data from the 1990 U.S. Census are presented, keeping with the established practice of using federal census data for environmental justice analysis. Unfortunately for this analysis, however, the crab fishery has changed a great deal since 1990 in many ways, including the size and distribution of the workforce. Therefore, the 1990 census data were supplemented with data gathered from industry sources that characterize their workforce demographics for 2000. These data suggest that the workforce has come to include a much larger minority population component than was the case a decade earlier and reflected in the 1990 census information.

Some caution must be given, however, in the comparison of the two different 1990 and 2000 resident workforce-related data types. That is, in order to supplement the 2000 U.S. Census data that is being used to infer the structure of the locally present or resident fishery-associated workforce, industry was asked to provide 2000 workforce demographics for their individual crab processing operations.[2] It is important to note

[2] During discussion of the environmental justice analysis for another fishery SEIS at the October 2001 meetings of the NPFMC in Seattle, the question was raised during the Advisory Panel discussion of whether environmental justice provisions applied to non-U.S. citizens, and the implication of this question for the analysis, given that a substantial number of resident aliens work in the local seafood processing plants. If it is assumed that Executive Order 12898 is premised on the application of the equal protection clause, then it should not matter whether the affected population consists entirely or primarily of citizens or resident aliens. A long line of Supreme Court cases holds that the Equal Protection Clause of the U.S. Constitution applies to resident aliens (See Kim Ho Ma v. Ashcroft, 257 F. 3d 1095, 1108-09 and fn. 23 [July 27, 2001]). Although a distinction has been drawn concerning the extent to which constitutional protections may apply to non-resident aliens who are seeking admission to the United States but are not yet present within its borders, the clear weight of authority holds that once an alien is present within the borders of the United States, regardless of whether his or her entry was legal or illegal, he or she has constitutional rights, including the right to equal protection of the laws (Id. at 1109). Importantly, the EPA defines environmental justice to mean the "fair treatment of people of all races, cultures, and incomes" and guidelines include: "Conducting our programs, policies, and activities that substantially affect human health and the environment in a manner that ensures the fair treatment of *all people*, including minority populations and/or low-income populations; Ensuring *equal enforcement* of protective environmental laws for all people, including minority populations and/or low-income populations" (<http://www.epa.gov/swerosps/ej/html-doc/ejmemo.htm>, emphasis added). Further, the EPA Environmental Justice "F.A.Q." answers the question of "What is Environmental Justice?" by stating it is "To ensure that *all people*, regardless of race, *national origin* or income are protected from disproportionate impacts of environmental hazards" (<http ://es.epa.goc/oeca/main/ej/faq.html>, emphasis added). Additionally, data gathered by the U.S. Bureau of the Census often constitute the statistical foundation for examining the environmental justice implications of government decisions, and the decennial census remains the most widely used source of data to characterize populations based on race or ethnicity (Gerrard 1999). The methodology of the Census, i.e., where all persons are counted, argues strongly for the inclusion of foreign nationals in the environmental justice analysis. By way of background, the first U.S. decennial census in 1790 established the concept of "usual residence" as the main principle in determining where people were to be counted. This concept has been followed in all subsequent censuses. Usual residence has been defined as the place where the person lives and sleeps most of the time and is not necessarily the same as the person's voting or legal residence. Also, noncitizens who are living in the United States are included, regardless of their immigration status (although foreign nationals who are visiting the country only briefly or reside in foreign embassies are not counted). There have been acknowledged difficulties with counting persons of questionable residency status, and on March 13, 2000, the Immigration and Naturalization Service (INS) issued a memo outlining the guidelines for the INS' operations during the 2000 census. In general, the INS has taken the position that all foreign nationals, even those who are in the United States illegally, should participate in the census. However, it is generally believed that past census counts have undercounted the nation's illegal alien population. To prevent this during the 2000 census, the INS issued these

that these data were not collected using a methodology similar to that used for the U.S. Census data, and this should be taken into account in the interpretation of the information. These data are self-reported and, like other self-reported data, there may be an inherent self-interest bias to at least some degree found within the information. Whatever bias exists, however, is considered likely to be relatively small and not sufficient to materially alter the overall assessment of whether the local seafood processing workforce represents a population segment that is "meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis" such as the specific community or region. Further, in each relevant Alaska community, these data are supplemented with age and sex data from the 1990 and 2000 U.S. Census that allow a cross-check on the both the gross and relative changes in the "industrial" population segment in the communities.

The situation is markedly different for the greater Seattle area. Seattle is, in absolute terms, the community most engaged in the crab fishery when considering many of the important indices of involvement, but it is also the least engaged in the fishery (or, perhaps more accurately, the least dependent upon the fishery) in terms of the relative importance of the fishery to the overall population and economy of the community (as discussed in detail in Appendix 3). Summary information relevant to Seattle environmental justice considerations is presented at the end of this section.

The CDQ region presents yet another type of environmental justice context, through the nature of the demographic and economic structure of this region, and the nature of the participation of this region and its communities in the fishery through the various mechanisms of the CDQ program as it has been implemented in different subregions by different CDQ groups. This is noted at the end of this section and discussed in detail in Appendix 3.

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guidelines, to ensure that no information gained through the census will be obtained or used by the INS against illegal aliens. Moreover, according to the comprehensive text *The Law of Environmental Justice* (Gerrard, 1999) both EPA and the General Service Administration (GSA) guidance documents generally concur with CEQ's data collection and environmental assessment strategy, and both go further in their own recommendations. In addition to identifying the proportion of the population of individual census tracts that are composed of minority individuals, EPA suggests that its analysts also attempt to identify whether "high concentration 'pockets' of minority populations are evidenced in specific geographic areas." EPA cautions that traditional census-based population tract data may miss high "pockets" of minority or low-income communities. Census data have proven unreliable in some cases, "in part because the level of aggregation may not offer a fine enough mesh to identify the existence of minority and/or low-income populations." As such, and because census data rely on self-reporting, these data are not always "consistent" and are "prone to undercounting" minority and low-income populations "due to a perceived reluctance for certain population to divulge information." EPA thus recommends that census data be supplemented with data from other sources, such as local agencies; locality-specific questions, interviews, and research; outreach to community groups; geographical information system (GIS), or other mapping systems. In this specific EIS instance, industry-provided data are used to identify such "pockets" of minority populations within various crab communities that are relevant to the analysis of the proposed alternatives. (Further details on Alaska residency versus non-state residency are discussed in Appendix 3 but are not relevant here, due to the fact that EO 12898 is a federal and not a state directive.)

4.7.1.3 Alaska communities

General community population attributes

Alaska communities with the strongest direct engagement in, and dependence upon, the BSAI crab fishery are Unalaska/Dutch Harbor, Akutan, King Cove, Sand Point, Adak, St. Paul, St. George, and Kodiak. These eight communities, and their specific ties to the crab fishery, are profiled in detail in Appendix 3. In this section, community level information relevant to environmental justice analysis is summarized.

Minority populations

Table 4.7-1 provides ethnicity information from the 2000 census for each of the eight communities.[3] As shown, these communities vary widely in their population structure. For example, Unalaska the second largest community and has the lowest Alaska Native population percentage. St. Paul and St. George have a much higher Alaska Native population component than any of the other communities shown. (Akutan, while having a relatively low Alaska Native population percentage is, however, arguably one of the "most traditional" Aleut communities, as noted below.) Unalaska, Adak, and Kodiak have far higher white or non-minority population percentages than the other five communities. Asian residents represent the largest population segment in Akutan, and the second largest in Unalaska and Kodiak (behind whites) as well as in King Cove (behind Alaska Natives), and the third largest in Sand Point (behind Alaska Natives and whites). These communities have quite different histories with respect to the growth of the different population segments present in the community in 2000. Each is summarized briefly below. One important constant across all of these communities is that each is a "minority community" in the sense that minorities make up a majority of the population in each community.

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[3] As a methodological note, some community populations vary considerably throughout the year as seasonal workers are brought in to the smaller Alaska communities to provide an adequate workforce for peak seafood processing demand. U.S. Census data do not take yearly averages but rather represent a one-time count. During the 1990 Census, for example, information for rural Alaska communities was collected during the months of January through April 1990 according to the Institute for Social and Economic Research at the University of Alaska. Although these data cannot represent the complexity of crab community population dynamics, they do represent the best available data set that is comparable across communities and regions.

Table 4.7-1 Ethnic composition of population, selected Alaska BSAI crab communities, 2000.

Race/Ethnicity	Unalaska		Akutan		King Cove		Sand Point		Adak		St. Paul		St. George		Kodiak	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
White	1,893	44.2%	168	23.6%	119	15.0%	264	27.7%	157	49.7%	69	13.0%	12	7.9%	2,939	46.4%
Black/African American	157	3.7%	15	2.2%	13	1.6%	14	1.5%	4	1.3%	0	0.0%	0	0.0%	44	0.7%
Native American/ Alaska Native	330	7.7%	112	15.7%	370	46.7%	403	42.3%	111	35.1%	457	85.9%	140	92.1%	663	10.5%
Nat. Hawaiian/ Other Pac Islander	24	0.6%	2	0.3%	1	0.1%	3	0.3%	6	1.9%	3	0.1%	0	0.0%	59	0.9%
Asian	1,312	30.6%	275	38.6%	212	26.8%	221	23.2%	31	9.9%	0	0.0%	0	0.0%	2,010	31.7%
Some Other Race	399	9.3%	130	18.2%	47	5.9%	21	2.2%	0	0.0%	0	0.0%	0	0.0%	276	4.4%
Two Or More Races	168	3.9%	11	1.5%	30	3.8%	26	2.7%	7	2.2%	3	0.1%	0	0.0%	343	5.4%
Total	4,283	100%	713	100%	792	100%	952	100%	316	100%	532	100%	152	100%	6,334	100%
Hispanic*	551	12.9%	148	20.8%	59	7.4%	129	13.6%	16	5.1%	0	0.0%	0	0.0%	541	8.5%

Source: U.S. Bureau of Census.

* "Hispanic" is an ethnic category and may include individuals of any race (and therefore is not included in the total as this would result in double counting).

Unalaska may be described as a plural or complex community in terms of the ethnic composition of its population. Although Unalaska was traditionally an Aleut community, the ethnic composition has changed with people moving into the community on both a short-term and long-term basis. Not surprisingly, in the latter half of the 20th century, population fluctuations have coincided with periods of resource exploitation and scarcity.[4] For example, the economic and demographic expansion associated with the King crab boom in the late 1970s and early 1980s brought many non-Aleuts to Unalaska, including Euro-North Americans, Filipinos, Vietnamese, Koreans, and Hispanics. The Euro-American population shows a distinct change over the years, comprising around 30 percent of the population in 1970, over 60 percent in 1980 and 1990, and then back to 44 percent in 2000. The growth of the Asian/Pacific Islander population (over 30 percent by 2000) is closely associated with the increasingly residential nature of the seafood processing sector workforce. Apart from the War years, prior to the growth of the current commercial fisheries-based economy, Unalaska was an Aleut community. Since this development, however, the change over the period of 1970-1990 is striking. In 1970, Aleut individuals made up slightly over 60 percent of the total community population (and Alaska Natives accounted for a total of 63 percent of the population). In 1980, Alaska Natives, including Aleuts, accounted for 15 percent of the population; by 1990, Aleuts comprised only 7 percent of the total community population (with Alaska Natives as a whole accounting for 8 percent of the population). Overall representation was similar in 2000. This population shift is largely attributable to fisheries and fisheries-related economic development and associated immigration.[5]

Akutan is a unique community in terms of its relationship to the Bering Sea crab fishery. It is the site of one of the largest of the shoreplants in the region, but it is also the site of a village that is geographically and socially distinct from the shoreplant. This 'duality' of structure has had marked consequences for the relationship of Akutan to fishery. One example of this may be found in Akutan's status as a CDQ community. Initially (in 1992), Akutan was (along with Unalaska) deemed not eligible for participation in the CDQ program based upon the fact that the community was home to "previously developed harvesting or processing capability sufficient to support substantial groundfish participation in the BSAI . . ." though they met all other qualifying criteria. The Akutan Traditional Council initiated action to show that the community of Akutan, per se, was separate and distinct from the seafood processing plant some distance away from the residential community site, that interactions between the community and the plant were of a limited nature, and that the plant was not incorporated into the fabric of the community such that little opportunity existed for Akutan residents to participate meaningfully in the Bering Sea pollock fishery (i.e., it was argued that the plant was essentially an industrial enclave or worksite separate and distinct from the traditional community of Akutan and that few, if any, Akutan residents worked at the plant). With the support of the Aleutian Pribilof Island Community Development Association (APICDA) and others, Akutan was successful in a subsequent attempt to become a CDQ community and obtained that status in 1996. This action highlights the

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[4] The most dramatic population shift of this century, however, was brought about by World War II. The story of the War, and the implications for the Aleut population of Unalaska and the other Aleut communities of Unalaska Island, is too complex and profound for treatment in this limited community profile. It may be fairly stated, however, that the events associated with World War II, including the Aleut evacuation and the consolidation of the outlying villages, forever changed the community and Aleut sociocultural structure.

[5] The fact that there is a "core" Aleut population of the community with a historical continuity to the past also has implications for contemporary fishery management issues. These include the activities of the Unalaska Native Fisherman Association and active local involvement in the regional CDQ program. While neither of these undertakings excludes non-Aleuts, Aleut individuals are disproportionately actively involved (relative to their overall representation in the community population).

fundamentally different nature of Akutan and Unalaska. Akutan, while deriving economic benefits from the presence of a large shoreplant near the community proper, has not incorporated large-scale commercial fishing activity with the daily life of the community as has Unalaska, nor has it developed the type of support economy that is a central part of the socioeconomic structure of Unalaska. While U.S. Census figures show Akutan had a population of 589 in 1990 and 713 in 2000, the Traditional Council considers the "local" resident population of the community to be around 80 persons, with the balance being considered "non-resident employees" of the seafood plant. This definition obviously differs from census, state, and electoral definitions of residency but is reflective of the social reality of Akutan. The residents of the village of Akutan, proper, are almost all Aleut.

Sand Point and King Cove share a more or less common development history, but one quite different from either Unalaska or Akutan. Sand Point was founded in 1898 by a San Francisco fishing company as a trading post and cod fishing station. Aleuts from surrounding villages and Scandinavian fishermen were the first residents of the community. King Cove was founded in 1911 when Pacific American Fisheries built a salmon cannery. Early settlers were Scandinavian, European, and Aleut fishermen. Historically, both of these communities saw a large influx of non-resident fish tenders, seafood processing workers, fishers, and crew members each summer. For the last several decades, both communities were primarily involved in the commercial salmon fisheries of the area, but with the decline of the salmon fishery, plants in both communities have diversified into other species. In more recent years, the processing plants in both communities have become heavily involved in the groundfish fishery, although their structural relationships to the fishery have diverted since the passage of the American Fisheries Act (AFA). As detailed in Appendix 3, processing facilities in both communities qualified as AFA entities; however, King Cove qualified for a locally based CV co-op while Sand Point did not. Both King Cove and Sand Point have sizable local CV fleets, unlike Unalaska and Akutan. At present, facilities in King Cove process significant volumes of BSAI crab, while those in Sand Point do not.

The contemporary community of Adak traces its origin to a military settlement, not a traditional Aleut village like Unalaska, or a commercial fishing outpost like King Cove. Adak, in its historical configuration, lost its "reason for being" as a result of the military base realignment and closure process in the mid-1990s. While there has been a continuity of the physical structure of the community - structures built by and for the military are housing current residents and businesses - the community has seen a population turnover with conversion to a civilian settlement. The present population of the community comes from an entirely different set of socioeconomic and cultural circumstances than the population that built the physical community. From a demographic perspective, the Adak of 2000 is literally not the same community as the Adak of 1990. Although the contemporary population does not have an Aleut majority, the community is very much an Aleut community by virtue of the driving role of the Aleut Corporation in its foundation and development and the predominant role of Aleut individuals in local governmental positions. Adak did not qualify as an Alaska Native village under the terms of ANCSA, due to the fact that it was essentially a non-Native community at the time of the passage of the Act (1971). The Aleut Corporation is currently developing Adak as a commercial center, and this development focuses heavily on the potential for commercial fishing, and support of commercial fishing activities, in the Western Aleutians area of the Bering Sea and the North Pacific Ocean. As a new civilian community, Adak does not have an established residential fishing fleet. There is a single processing plant in the community, and it has seen a number of ownership transitions in recent years. The community has also seen at least some crab and cod activity related to other seafood firms.

The Pribilof Islands were encountered in 1786 by Russian fur traders who landed first on St. George and originally named the larger island to the north St. Peter and St. Paul Island. Beginning in 1788, the Russian American Company relocated indentured or enslaved Aleuts from Siberia, Atka, and Unalaska to the Pribilofs to hunt fur seals, and the contemporary population of the communities of St. Paul and St. George trace their ancestry to those original hunters. The island was administered by the Russian American Company until the sale and transfer of Alaska from Russia to the United States in 1867. In 1870, the Alaska Commercial Company was awarded a 20-year sealing lease by the U.S. Government and provided housing, food, and medical care to the Aleuts in exchange for seal harvesting. In 1890, a second 20-year lease was awarded to the North American Commercial Company. The 1910 Fur Seal Act ended private leasing on the Islands and placed the community and fur seals under the U.S. Bureau of Fisheries. In 1983, Congress passed the Fur Seal Act Amendments, which ended government control of the commercial seal harvest and the effective federal domination of daily life on the island. Commercial sealing was discontinued shortly after. The local commercial halibut fishery got its start in 1981, and a crab processing plant was built several years later. Local residents hold commercial fishing permits for halibut, a few own halibut IFQs, and local boats also fish for CDQ halibut. There are onshore processing facilities on St. Paul, and crab is processed on mobile processing platforms in both St. Paul and St. George.

Kodiak is a complex community in terms of the ethnic composition of its population. Sugpiaqs (Koniags) were the original inhabitants of Kodiak Island. Beyond earlier development, fishing and military buildup associated with World War II brought many non-Natives to Kodiak, primarily Caucasians but also a substantial number of non-Native minorities, at least initially associated primarily with fish processing employment. Detailed information on community growth and the relative growth of different population segments is provided in Appendix 3. The Alaskan Native population has remained at approximately the same percentage since the 1970s, but the white (non-minority) population has declined in terms of percentage over time due to immigration of non-white and non-Native individuals to the community in response, at least in part, to economic opportunities provided by the commercial fishery.

Low-income populations

The following two tables present information on income, employment, and poverty for the Alaska communities most heavily engaged in the BSAI crab fishery. These tables are based on 2000 U.S. Census data and they provide useful comparative information. Table 4.7-2 displays median household and family income. As shown, the range is large for the communities listed. For example, median family income in Unalaska is almost twice a large as the comparable figure for Akutan. This does not reflect the entire range for the Aleutian/Pribilof region, however, as a two communities in the region without commercial crab development (Atka and Nikolski) have a lower median family income than Akutan. In 2000, Unalaska had the highest median family income in the Aleutian/Pribilofs region at $80,829 and Atka had the lowest at $34,375.

Table 4.7-2 Household income information, selected Alaska Bering Sea and Aleutian Island crab communities, 2000.

Community	Housing Units	Occupied Housing Unites	Vacant Housing Units	Total Households	Average Persons Per HH	Median HH Income	Family Households	Median Family Income
Unalaska	988	834	154	834	2.51	$69,539	476	$80,829
Akutan	38	34	4	34	2.21	$33,750	18	$43,125
King Cove	207	170	37	170	2.90	$45,893	117	$47,188
Sand Point	282	229	53	229	2.67	$55,417	156	$58,000
Adak	884	159	725	159	1.99	$52,727	61	$53,899
St. Paul	214	177	37	177	2.88	$50,750	123	$51,750
St. George	67	51	16	51	2.98	$57,083	42	$60,625
Kodiak	2,255	1,996	259	1,996	3.10	$55,142	1,362	$60,484

Source: U.S. Bureau of Census

Table 4.7-3 displays data on employment and poverty information for the relevant communities for 2000. These data must be interpreted with some caution, as it is apparent that the census that generated these figures must have occurred at a time when seafood processing workers were present but idle in some of the communities. For example, Akutan with a total population of 713, is shown has having 505 unemployed persons with an unemployment rate of 78.9 percent. Given that Akutan consists of a traditional community of about 80 residents and a large seafood processing facility whose workers account for over 600 community residents, it is obvious that the census took place while seafood processing workers were present but not employed, which is not a typical situation. In contrast, the 1990 census occurred when the processing plant was operating, and only 2 out of 527 residents were unemployed, with an unemployment rate of 0.4 percent. In the 1990 census, every community in the Aleutian/Pribilof region with major seafood processing plants had an unemployment rate of less than 3 percent. In the 2000 census, it would appear that idled seafood workers were counted in significant numbers in, at a minimum, Unalaska, Akutan, and Sand Point. In terms of variation in poverty status, in 2000, the percent of poverty in the Aleutian/Pribilof region ranged from 4.7 percent in Adak to 45.5 percent in Akutan, but again the figure of Akutan appears to be an artifact of census timing. Data from the full range of communities in the Aleutian/Pribilof region do not vary consistently with the presence or absence of commercial fishery development as might be expected. For example, Nelson Lagoon shows a very high rate of unemployment (28.6 percent) and adults not working (66.7 percent), yet there is a smaller percentage of persons in poverty (6.4 percent) than in the communities with large shoreplants (Unalaska, Akutan, King Cove, and Sand Point). This does not fit the typical pattern as seen in field observations and shown in the 1990 census data where the contrast between commercial fishing communities and the other communities in the region is reflective of both lack of economic development in the latter communities and the nature of the workforce population in communities with shore plants, where large numbers of processing workers are present, tend not to have non-working adult family members present with them, and tend to be in the community exclusively for employment purposes.

Table 4.7-3 Employment and poverty information, selected Alaska Bering Sea and Aleutian Island crab communities, 2000.

Community	Total Persons Employed	Unemployed	Percent Unemployment	Percent Adults Not Working	Not Seeking Employment	Percent Poverty
Unalaska	2,675	414	11.1%	27.93%	625	12.5%
Akutan	97	505	78.9%	84.84%	38	45.5%
King Cove	450	31	4.7%	31.50%	176	11.9%
Sand Point	427	190	22.8%	48.67%	215	16.0%
Adak	196	16	6.7%	16.31%	23	4.7%
St. Paul	227	40	9.1%	39.22%	143	11.9%
St. George	76	3	3.1%	21.64%	18	7.9%
Kodiak	3,053	160	3.6%	29.62%	1,170	7.4%

Source: U.S. Bureau of Census

Population attributes of the resident crab fishery workforce

Beyond the overall population figures for the individual communities, it is important for the purposes of environmental justice analysis to examine information on the residential crab fishery workforces. It is likely that employment and income losses associated with at least one or more the alternatives would be felt among the local seafood processing workers, and these workers do not represent a random cross section of the community demography. One method to examine the relative demographic composition of the local processing workforces is to utilize group quarters housing data from the U.S. Census (keeping with the established practice of using U.S. Census data for environmental justice analysis). This information is presented by community in the following series of tables. Unfortunately, ethnicity by housing type for the 2000 census has not yet been released at the time of this writing. The group ethnicity by housing type data in the following tables are therefore drawn from the 1990 census (and a subsequent section supplements this information with industry-provided figures for 2000, see below). This is supplemented by group housing totals and age and sex data from the 1990 and 2000 U.S. Census to provide a cross-check of census (and industry provided) data and the population structure over this period as well.

Group housing in Unalaska is largely associated with the seafood processing workforce. As shown in Table 4.7-4, 52 percent of the population lived in group housing in 1990 and 51 percent of the population did so in 2000.

Table 4.7-4 Group quarters housing information, Unalaska, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	3,089	1,614	52.25%	1,475	47.75%
2000	4,283	2,192	51.18%	2,091	48.82%

Source: U.S. Bureau of the Census 1990 STF2, Census 2000 Summary File 1

Table 4.7-5 provides information on group housing and ethnicity for Unalaska. Group housing in the community is largely associated with the processing workforce. As shown, 52 percent of the population lived in group housing in 1990. Also as shown, the total minority population proportion was substantially higher in group quarters (49 percent) than in non-group quarters (31 percent). With the population growth seen in association with the development of the commercial fishing industry, Unalaska's population has had significantly more men than women. Historically, this has been attributed to the importance of the fishing industry in bringing in transient laborers, most of whom were young males. Table 4.7-6 portrays the changes in proportion of males and females in the population for the years 1970, 1980, 1990, and 2000. Census data from the period 1970-1990 showed a climb in median age from 26.3 years to 30.3 years and then a further jump to 36.5 years in 2000. This is commonly attributed to the relative size of the workforce in comparison to resident families.

Table 4.7-5 Ethnicity and group quarters housing information, Unalaska, 1990.

Unalaska City	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	1917	62.06%	870	53.90%	1047	70.98%
Black or African American	63	2.04%	55	3.41%	8	0.54%
American Indian, Eskimo, Aleut	259	8.38%	20	1.24%	239	16.20%
Asian or Pacific Islander	593	19.20%	434	26.89%	159	10.78%
Other Race	257	8.32%	235	14.56%	22	1.49%
Total Population	3089	100.00%	1614	100.00%	1475	100.00%
Hispanic Origin, Any Race	394	12.75%	337	20.88%	57	3.86%
Total Minority Population	1252	40.53%	795	49.26%	457	30.98%
Total Non-Minority Pop (White Non-Hispanic)	1837	59.47%	819	50.74%	1018	69.02%

Source: U.S. Bureau of the Census 1990 STF2

Table 4.7-6 Population by age and sex, Unalaska: 1970, 1980, 1990, and 2000.

Attribute	1970		1980		1990		2000	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Male	98	55%	858	65%	2,194	71%	2,830	66%
Female	80	45%	464	35%	895	29%	1,453	34%
Total	178	100%	1,322	100%	3,089	100%	4,283	100%
Median Age	26.3 years		26.8 years		30.3 years		36.5 years	

Source: U.S. Bureau of Census

Group housing in Akutan is almost exclusively associated with the seafood processing workforce. As shown in Table 4.7-7, in 1990 fully 85 percent of the population lived in group quarters and only 15 percent did not. As seen in this same table, in 2000 an even greater percentage of the total population lived in group quarters (89 percent versus 11percent not in group quarters).

Table 4.7-7 Group quarters housing information, Akutan, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	589	501	85.06%	88	14.94%
2000	713	638	89.48%	75	10.52%

Source: U.S. Bureau of the Census 1990 STF2, Census 2000 Summary File 1

Table 4.7-8 provides information on group housing and ethnicity for Akutan. The 85 percent of the population living in group housing in 1990 represents the extreme of the crab communities profiled. As shown, the ethnic composition of the group and non-group housing segments were markedly different, with the non-group housing population being predominately (83 percent) Alaska Native, and the group housing population having almost no (1 percent) Alaska Native representation. Table 4.7-9 shows the population composition by sex in 1990 and 2000 and is clearly indicative of a male-dominated industrial site rather than a typical residential community.

Table 4.7-8 Ethnicity and group quarters housing information, Akutan, 1990.

Akutan	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	227	37.52%	212	42.32%	15	17.05%
Black or African American	6	0.99%	6	1.20%	0	0.00%
American Indian, Eskimo, Aleut	80	13.22%	7	1.40%	73	82.95%
Asian or Pacific Islander	247	40.83%	247	49.30%	0	0.00%
Other Race	29	4.79%	29	5.79%	0	0.00%
Total Population	589	100.00%	501	100.00%	88	100.00%
Hispanic Origin, Any Race	45	7.44%	45	8.98%	0	0.00%
Total Minority Population	342	56.53%	298	59.48%	73	82.95%
Total Non-Minority Pop (White Non-Hispanic)	247	40.83%	203	40.52%	15	17.05%

Source: U.S. Bureau of the Census 1990 STF2

Table 4.7-9 Population by age and sex, Akutan: 1990 and 2000.

Attribute	1990		2000	
	Number	Percent	Number	Percent
Male	449	76%	549	77%
Female	140	24%	164	23%
Total	589	100%	713	100%
Median Age	NA		40.2 years	

Source: U.S. Bureau of Census

Group housing in King Cove is largely associated with the seafood processing workforce. As shown in Table 4.7-10, 42 percent of the population lived in group housing in 1990 and 38 percent of the population did so in 2000.

Table 4.7-10 Group quarters housing information, King Cove, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	451	189	41.91%	262	58.09%
2000	792	299	37.75%	493	62.25%

Source: U.S. Bureau of the Census 1990 STF2, Census 2000 Summary File 1

Table 4.7-11 provides information on group housing and ethnicity for King Cove. As shown, ethnicity varied between the group and non-group housing, with the non-group housing population being 67 percent Alaska Native and 6 percent Asian or Pacific Islander and the group housing population being less than 1 percent Alaska Native and 58 percent Asian or Pacific Islander. The male to female ratio shown in Table 4.7-12 is also consistent with a transient workforce.

Table 4.7-11 Ethnicity and group quarters housing information, King Cove, 1990.

King Cove	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	127	28.16%	57	30.16%	70	26.72%
Black or African American	6	1.33%	6	3.17%	0	0.00%
American Indian, Eskimo, Aleut	177	39.25%	1	0.53%	176	67.18%
Asian or Pacific Islander	125	27.72%	109	57.67%	16	6.11%
Other Race	16	3.55%	16	8.47%	0	0.00%
Total Population	451	100.00%	189	100.00%	262	100.00%
Hispanic Origin, Any Race	53	11.75%	53	28.04%	0	0.00%
Total Minority Population	331	73.39%	139	73.54%	192	73.28%
Total Non-Minority Pop (White Non-Hispanic)	120	26.61%	50	26.46%	70	26.72%

Source: U.S. Bureau of the Census 1990 STF2

Table 4.7-12 Population by age and sex, King Cove: 1990 and 2000.

Attribute	1990		2000	
	Number	Percent	Number	Percent
Male	292	65%	472	60%
Female	159	35%	320	40%
Total	451	100%	792	100%
Median Age	NA		34.9 years	

Source: U.S. Bureau of Census

Group housing in Sand Point, like the other communities previously mentioned, is largely associated with the seafood processing workforce. As shown in Table 4.7-13, 22 percent of the population lived in group housing in 1990 and 36 percent of the population did so in 2000.

Table 4.7-13 Group quarters housing information, Sand Point, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	878	189	21.53%	689	78.47%
2000	952	340	35.71%	612	64.28%

Source: U.S. Bureau of the Census 1990 STF2, Census 2000 Summary File 1

Table 4.7-14 provides information on group housing and ethnicity for Sand Point. As shown, almost no Alaska Natives live in group quarters, while few Asians live outside of group quarters. As shown in Table 4.7-15, the significant male to female imbalance seen in other communities is present in Sand Point as well.

Table 4.7-14 Ethnicity and group quarters housing information, Sand Point, 1990.

Sand Point	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	284	32.35%	48	25.40%	236	34.25%
Black or African American	4	0.46%	4	2.12%	0	0.00%
American Indian, Eskimo, Aleut	433	49.32%	3	1.59%	430	62.41%
Asian or Pacific Islander	87	9.91%	80	42.33%	7	1.02%
Other Race	70	7.97%	54	28.57%	16	2.32%
Total Population	878	100.00%	189	100.00%	689	100.00%
Hispanic Origin, Any Race	78	8.88%	58	30.69%	20	2.90%
Total Minority Population	601	68.45%	146	77.24%	455	66.04%
Total Non-Minority Pop (White Non-Hispanic)	277	31.55%	43	22.76%	234	33.96%

Source: U.S. Bureau of the Census 1990 STF2

Table 4.7-15 Population by age and sex, Sand Point: 1990 and 2000.

Attribute	1990		2000	
	Number	Percent	Number	Percent
Male	557	63%	593	62%
Female	321	37%	359	38%
Total	878	100%	952	100%
Median Age	NA		36.5 years	

Source: U.S. Bureau of Census

The group housing situation in Adak is markedly different than in the other communities discussed.[6] While group housing in the other communities has normally been associated with the seafood processing workforce, in Adak group housing was associated with the military. As shown in Table 4.7-16, 30 percent of the population lived in group housing in 1990 when Adak was still a military community, and none of the population lived in group housing in 2000 after conversion to a civilian community.

Table 4.7-16 Group quarters housing information, Adak, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	4,633	1,391	30.02%	3,242	69.98%
2000	316	0	0.00%	316	100.00%

Source: U.S. Bureau of the Census 1990 STF2, Census 2000 Summary File 1

Table 4.7-17 provides 1990 census information on group housing and ethnicity for Adak. These data are reflective of the former military population structure, and not of the contemporary civilian community (but are presented here for the sake of continuity of treatment with the other communities profiled). Table 4.7-18 provides information on age and the male/female ratio of Adak's population in 1990 and 2000. Perhaps counterintuitively, Adak has a greater male to female imbalance as a civilian community (in 2000) than it did as a military community (with dependent families) in 1990. The predominance of males in the 2000 community population is attributable to a male-dominated transient workforce, including base closure-related work as well as fisheries-related employment.

[6] Similarly, Adak is not comparable to other regional communities in terms of the infrastructure or other physical attributes of a community both in absolute terms or in terms of ratios of various service units to population. Constructed to support a military-related peak population nearly 20 times larger than the current population, and to support technically and logistically complex air, surface, and submarine combat and support operations, the physical community of Adak is of scale very much larger than required to support its current civilian population and economy. This situation is not unprecedented in the region, as it very closely parallels the circumstances of Unalaska immediately after World War II.

Table 4.7-17 Ethnicity and group quarters housing information, Adak, 1990.

Race/Ethnicity	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	3,655	78.89%	1,066	76.64%	2,589	79.86%
Black or African American	501	10.81%	222	15.96%	279	8.61%
American Indian, Eskimo, Aleut	55	1.19%	16	1.15%	39	1.20%
Asian or Pacific Islander	331	7.14%	53	3.81%	278	8.58%
Other Race	91	1.96%	34	2.44%	57	1.76%
Total Population	4,633	100.00%	1,391	100.00%	3,242	100.00%
Hispanic Origin, Any Race	255	5.50%	81	5.82%	174	5.37%
Total Minority Population	1,106	23.87%	361	25.95%	745	22.98%
Total Non-Minority Population (White Non-Hispanic)	3,527	76.13%	1,030	74.05%	2,497	77.02%

Source: U.S. Bureau of the Census 1990 STF2

Table 4.7-18 Population by age and sex, Adak: 1990 and 2000.

Attribute	1990		2000	
	Number	Percent	Number	Percent
Male	2,777	59.9%	205	64.9%
Female	1,856	40.1%	111	35.1%
Total	4,633	100%	316	100%
Median Age	NA		35.2 years	

Source: U.S. Bureau of Census

Group housing in St. Paul has historically been largely associated with federal employment, temporary construction projects, and seafood processing. Federal employment declined significantly prior to 1990. As shown in Table 4.7-19, 26 percent of the population lived in group housing in 1990, but only 4 percent did so in 2000. This sharp drop is attributable to a reduction in enumeration of fish processing employees (whether this was due only to a decline in such activity, or at least partially to change in the timing of such activity, is not clear). It is also likely a function of a decline in "special projects" (with outside workers) as well.

Table 4.7-19 Group quarters housing information, St. Paul, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	763	196	25.69%	567	74.31%
2000	532	22	4.13%	510	95.87%

Source: U.S. Bureau of the Census 1990 STF2, Census 2000 Summary File 1

Table 4.7-20 provides 1990 census information on group housing and ethnicity for St. Paul. Also as shown, ethnicity varied strikingly between the group and non-group housing, with the non-group housing population being 88 percent Alaska Native and the group housing population being only 2 percent Alaska Native. Table 4.7-21 provides information on the age and the male/female ratio of St. Paul's population in 1990 and 2000. As shown, there was a larger male to female imbalance in 1990 than is seen in 2000. This, like the changes seen in overall population, ethnic composition of the population, and proportion of the population living in group quarters, can be attributed to the lack of a transitory or mobile labor force in 2000, which has resulted in the community having less of an “industrial” or “institutional” type of population and more of a “residential” type of community population.

Table 4.7-20 Ethnicity and group quarters housing information, St. Paul, 1990.

Race/Ethnicity	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	164	21.5%	99	50.5%	65	11.5%
Black or African American	12	1.6%	12	6.1%	0	0.0%
American Indian, Eskimo, Aleut	504	66.1%	4	2.0%	500	88.2%
Asian or Pacific Islander	44	5.8%	42	21.4%	2	0.4%
Other Race	39	5.1%	39	19.9%	0	0.0%
Total Population	763	100.0%	196	100.0%	567	100.0%
Hispanic Origin, Any Race	62	8.1%	59	30.1%	3	0.5%
Total Minority Population	605	79.3%	102	52.0%	503	88.7%
Total Non-Minority Population (White Non-Hispanic)	158	20.7%	94	48.0%	64	11.3%

Source: U.S. Bureau of the Census 1990 STF2

Table 4.7-21 Population by age and sex, St. Paul: 1990, and 2000.

Attribute	1990		2000	
	Number	Percent	Number	Percent
Male	478	62.6%	294	55.3%
Female	285	37.3%	238	44.7%
Total	763	100%	532	100%
Median Age	NA		31.9 years	

Source: U.S. Bureau of Census

St. George has yet a different population structure. As shown in Table 4.7-22, none of the residents of St. George lived in group quarters in 1990 or 2000. This is consistent with no commercial seafood processing taking place on shore in the community during this period.

Table 4.7-22 Group quarters housing information, St. George, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	138	0	0.0%	138	100.0%
2000	152	0	0.0%	152	100.0%

Source: U.S. Bureau of the Census 1990 STF2, Census 2000 Summary File 1

Table 4.7-23 provides a breakout by ethnicity for St. George's population by housing type for 1990. As shown in Table 4.7-24, the male to female ratio is much closer to an even distribution reflective of a typical residential population than is seen in any of the other communities profiled. Alone among the communities discussed, females outnumber males in St. George. Unlike the other communities profiled, St. George has seen virtually no commercial fisheries development onshore.

Table 4.7-23 Ethnicity and group quarters housing information, St. George, 1990.

Race/Ethnicity	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	7	5.1%	0	0.0%	7	5.1%
Black or African American	0	0.0%	0	0.0%	0	0.0%
American Indian, Eskimo, Aleut	131	94.9%	0	0.0%	131	94.9%
Asian or Pacific Islander	0	0.0%	0	0.0%	0	0.0%
Other Race	0	0.0%	0	0.0%	0	0.0%
Total Population	138	100.0%	0	0.0%	138	100.0%
Hispanic Origin, Any Race	0	0.0%	0	0.0%	0	0.0%
Total Minority Population	131	94.9%	0	0.0%	131	94.9%
Total Non-Minority Pop (White Non-Hispanic)	7	5.1%	0	0.0%	7	5.1%

Source: U.S. Bureau of the Census 1990 STF2

Table 4.7-24 Population composition by sex, St. George; 1990 and 2000.

Attribute	1990		2000	
	Number	Percent	Number	Percent
Male	64	46.4%	73	48.0%
Female	74	53.6%	79	52.0%
Total	138	100.0%	152	100.0%
Median Age	NA		33.0 years	

Source: U.S. Bureau of the Census

In Kodiak, group housing is largely associated with the processing workforce, but not to the nearly exclusive degree seen in the large volume Aleutian crab communities, due to the greater complexity of the institutional base and range of housing types. As shown in Table 4.7-25, only 6 percent of the population lived in group housing in 1990, and this figure dropped to 2 percent in 2000. This is a much lower percentage of population residing in group quarters than for Unalaska, Akutan, King Cove, and Sand Point and is consistent with a workforce more heavily drawn from the local labor pool.

Table 4.7-25 Group quarters housing information, Kodiak, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	6,365	356	5.59%	6,009	94.41%
2000	6,334	146	2.30%	6,188	97.97%

Source: U.S. Bureau of the Census 1990 STF2, Census 2000 Summary File 1

Table 4.7-26 provides information on group housing and ethnicity for Kodiak. As shown, while there is still a significant difference between the group quarters and non-group quarters demographics (with the group quarters population being a higher minority group than the community population as a whole), the differences are not as sharp in general or for particular groups as seen in the Aleutian region communities that have seen intensive commercial fisheries development. In 1990, the group quarters population had a higher minority population percentage (51 percent) than the population of the community as a whole (37 percent). The male to female imbalance is present in the community, as shown in Table 4.7-27, but it is of a lesser magnitude than seen in the Aleutian region crab communities. This is consistent with Kodiak's fishery-related workforce being drawn more from the local community labor pool than is the case in the Aleutian communities.

Table 4.7-26 Ethnicity and group quarters housing information, Kodiak City, 1990.

Kodiak City	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	4028	63.28%	192	53.93%	3836	63.84%
Black or African American	29	0.46%	3	0.84%	26	0.43%
American Indian, Eskimo, Aleut	811	12.74%	21	5.90%	790	13.15%
Asian or Pacific Islander	1282	20.14%	118	33.15%	1164	19.37%
Other Race	197	3.10%	22	6.18%	175	2.91%
Total Population	6365	100.00%	356	100.00%	6009	100.00%
Hispanic Origin, Any Race	407	6.39%	42	11.80%	365	6.07%
Total Minority Population	2429	38.16%	181	50.84%	2248	37.41%
Total Non-Minority Pop (White Non-Hispanic)	3936	61.84%	175	49.16%	3761	62.59%

Source: U.S. Bureau of the Census 1990 STF2

Table 4.7-27 Population by age and sex, Kodiak City: 1990 and 2000.

Kodiak City	1990		2000	
	Number	Percent	Number	Percent
Male	3,496	55%	3379	53%
Female	2,869	45%	2955	47%
Total	6,363	100%	6334	100%
Median Age	NA		33.5 years	

Source: U.S. Bureau of the Census

Industry provided data

Information on workforce demographics for 2000 was obtained from firms operating four of the six major multi-species shoreplants in the Alaska Peninsula/Aleutian Islands region. Communities cannot be discussed individually because of confidentiality concerns. However, the total combined reported workforce of 2,364 persons was classified as 22.5 percent white or non-minority, and 77.5 percent minority. Reporting shoreplants ranged from having a 75 percent minority workforce to an over 90 percent minority workforce. It is worth noting that different firms provided different levels of detail in the breakout of the internal composition of the minority component of their workforce. For some plants, the total minority figure was not disaggregated, and too few plants provided detailed data to breakout discussions. However, all of the shoreplants in any region that provided detailed data have workforces that are 5 percent or less African American and 5 percent or less Alaska Native/Native American. The group classified as Asian/Pacific Islander was the largest minority group in two-thirds of the plants in any region reporting detailed data, and the group classified as Hispanic was the largest minority group in the remaining one-third. Two entities provided time series data. One provided data spanning a 10-year period, while the other provided information covering a 4-year span. For the former, the minority workforce component increased over time; for the latter, no unidirectional trend existed.

Given the nature of the relationship between the processing workforce and the local communities, industry information comparable to that of the Aleutian region was not systematically collected from Kodiak entities. The information that was received was not sufficient to be able to disclose precise community level information due to confidentiality concerns. As a generality, however, the 2000 data received indicated that at least some shoreplants in this region have workforces with a greater minority population component than the Aleutian regional average (77.5 percent). This is despite the fact that, as a rule of thumb, the Kodiak processing workforce is drawn to a larger degree from a local labor pool than is the case for the Aleutian communities. As was the case for the Aleutian region, different firms provided different levels of detail in the breakout of the internal composition of the minority component of their workforce. For some plants, the total minority figure was not disaggregated, and not enough plants in Kodiak provided detailed data to allow a community-specific discussion. However, as mentioned above, all of the shoreplants in any region that provided detailed data have workforces 5 percent or less African American and 5 percent or less Alaska Native/Native American. For Kodiak, the group classified as Asian/Pacific Islander was the largest minority group noted within the limited detailed data obtained.

Alaska regional summary

The communities in the Aleutian/Pribilofs region that are most engaged in, and dependent upon, the crab fishery are those with populations comprised of more minority residents than non-minority residents. The structure of the minority population component varies from community to community, as does the proportion of the community population that is comprised of Alaska Native residents. Further, the workforce at the processing plants that would likely feel the impacts of the alternatives are overwhelmingly comprised of minority workers. While no systematic quantitative data are known, field observations would suggest that for a very substantial portion of the workforce, English is a second language (this is reinforced by data from local schools, such as in Unalaska, where 47 percent of the entering kindergarten students in 2000-2001 were ESL [English as a second language] students) and languages other than English are the commonly utilized in the workplace among processing crews. These factors, along with limited opportunity to acquire job skills in other economic sectors, would tend to indicate that these populations would be less able to easily acquire alternative employment outside of the seafood industry if there were widespread job reductions as a result of the alternatives. However, information on the level of job turnover/rates of rehire (discussed in Appendix 3) suggests that there is a fair degree of mobility among at least part of this workforce. Kodiak, like the communities profiled in the Aleutian/Pribilofs region, is comprised of more minority residents than non-minority residents. While systematic data do not exist, the data that are available suggest that the workforce at the processing plants that would likely feel the impacts of the alternatives are primarily comprised of minority workers.

4.7.1.4 Washington inland waters region

General community population attributes

The greater Seattle area is the center of much economic activity related to the BSAI crab fisheries, but the geographic footprint of those activities is difficult to define. It cannot be attributed to specific communities or neighborhoods in the same manner that Alaska communities may be linked to the fishery (as discussed in Appendix 3). For comparative purposes, Table 4.7-28 provides ethnicity data for the Seattle-Tacoma Consolidated Metropolitan Statistical Area (CMSA) as defined by the U.S. Bureau of the Census.[7] As shown, unlike the Alaska crab communities, the white portion of the population comprises a large majority of the overall population (i.e., minorities are actually a distinct mathematical minority, unlike the relevant Alaska communities).

[7] A CMSA consists of two or more contiguous MSAs The Seattle-Tacoma WA CMSA consists of Seattle WA PMSA (1) King and Snohomish Counties, and (2) Tacoma (Pierce County). A Metropolitan Statistical Area (MSA) can be defined as a city of over 50,000 inhabitants together with the county in which it is located and contiguous counties which are economically and socially integrated with the central city. It may also consist of an urbanized area of 50,000 with a total metropolitan area population of at least 100,000.

Table 4.7-28 Ethnic composition of population, Seattle-Tacoma Coastal Management Service Area 1990 and 2000.

Race/Ethnicity	1990		2000	
	Number	Percent	Number	Percent
White	2,214,579	86.5%	2,819,296	79.3%
African American	121,702	4.8%	165,938	4.7%
Native Amer/Alaskan	32,980	1.3%	41,731	1.2%
Asian/Pacific Islands*	164,386	6.4%	300,533	8.5%
Other**	25,517	1.0%	227,263	6.4%
Total	2,559,164	100%	3,554,760	100%
Hispanic***	71,069	2.8%	184,297	5.2%
Total Minority Population	383,198	15.0%	816,858	23.0%
Total Non-minority Population	2,175,966	85.0%	2,737,902	77.0%

Source: U.S. Bureau of Census.

* In the 2000 census, this was split into Native Hawaiian and Other Pacific Islander (pop 19,837 [0.6%]) and Asian (pop 280,696 [7.9%])

** In the 2000 census, this category was Some Other Race (pop 79,353 (2.2%)) and Two or More Races (pop 147,910 [4.2%]).

*** 'Hispanic' is an ethnic category and may include individuals of any race (and therefore is not included in the total as this would result in double counting).

Information on household income and employment and poverty information for the Seattle-Tacoma CMSA comparable to that provided for the relevant Alaska crab communities is not presented here. These types of data at the CMSA level are not meaningful for this environmental justice analysis.

Population attributes of the Seattle-based crab fishery workforce

Given the nature of engagement with the fishery, the Washington Inland Waters Region does not have the same type of resident workforce focused in individual communities in a manner comparable to that seen in Alaska communities, as discussed in detail in Appendix 3. No data on floating processors or C/P operated out of Seattle but not linked to a specific Alaska community were obtained. It is possible that the workforce is disproportionately comprised of minority individuals, but strength of ties to individual communities is unknown.

Washington inland waters regional summary

Environmental justice is not a regional or community level issue for BSAI crab management initiatives for the Washington inland waters region in general or the greater Seattle area in particular. Although quantitative data are not available to confirm this, based on interview data it does not appear to be an issue for the regionally based CV fleet either. As there are no Alaska crab shore-based processing entities in this region, the types of environmental justice issues associated with these workforces and seen in some of the Alaska communities are not present in this region. It is possible that C/P vessel workforces may have similar issues, but no data are available to confirm this.

4.7.1.5 Other/Alaska Native-specific environmental justice issues: community development quota region

The CDQ region of Western Alaska is an area of environmental justice concern with respect to the potential fishery management alternatives covered by this EIS. The CDQ program was specifically designed to foster fishery participation among, and direct fishery benefits toward, minority populations (87 percent of total population in these villages is comprised of Alaska Native residents) and low-income populations in the economically underdeveloped communities in Western Alaska. To the extent that the CDQ program has achieved these objectives, negative impacts to the CDQ program and communities are essentially, by definition, environmental justice impacts. CDQ region existing conditions are discussed in detail in Appendix 3, and summary information is presented in Section 3.4.5. CDQ-specific impacts potentially resulting from the alternatives are summarized in Section 4.6.8.

4.7.2 Environmental justice effects by alternative

The discussion in this section is organized into five different topical areas as outlined below. This discussion organization reflects the complexity of the environmental justice issue for the BSAI crab fishery, the range of communities and populations that may experience impacts, and the complex nature of ties of specific regions and communities to different sectors of the fishery, all of which have implications for environmental justice outcomes. Each topic is discussed in turn and includes conclusions by alternative, consistent with other social impact analysis sections. The individual topics are:

- Community level environmental justice impacts
- CV fleet-related environmental justice impacts
- C/P fleet-related environmental justice impacts
- Shore processor-related environmental justice impacts
- CDQ-related environmental justice impacts

4.7.2.1 Crab community level environmental justice impacts

Status quo alternative

Under the status quo alternative, no potential high and adverse impacts to minority populations or low-income populations in BSAI crab communities have been identified. Therefore, this is not considered to be an environmental justice issue under this alternative.

Three-pie voluntary cooperative alternative

A number of communities with Alaska Native majorities or pluralities actively participate in the BSAI crab fisheries. Under various rationalization approaches, consolidation of harvesting and processing sectors could take place that would serve to reduce or eliminate the participation of communities previously engaged in and dependent upon the fishery. Under the three-pie alternative, however, regionalization and community protection provisions serve as an impediment to consolidation and ensure that communities have a degree of control over that consolidation. As a result, no potential high and adverse impacts to minority populations or low-income populations in BSAI crab communities have been identified. Therefore, this is not considered to be an environmental justice issue under this alternative.

Individual fishing quota alternative

Under the IFQ alternative, regionalization provisions still apply, but community protection provisions do not (except for the waiver of sea time requirements for community purchase of harvester quota shares). Consolidation away from some communities with Alaska Native majorities or pluralities, such as St. George, are anticipated, as described in Section 4.6.5 and Appendix 3. These would qualify an environmental justice impacts.

Cooperative alternative

Under the cooperative alternative, regionalization does not apply (nor do community protection provisions). Consolidation away from the north region as a whole is anticipated. This would have high and adverse impacts to the Alaska Native communities in the Pribilofs, as detailed in the St. Paul and St. George community profiles in Appendix 3, and possibly other communities with Alaska Native pluralities in the south region.

4.7.2.2 Catcher vessel fleet-related environmental justice impacts

Status quo alternative

Under the status quo alternative, no potential high and adverse impacts to minority population or low-income population vessel owners or crews have been identified. Therefore, this is not considered to be an environmental justice issue under this alternative.

Three-pie voluntary cooperative alternative

Under the three-pie alternative, no potential high and adverse impacts to minority population or low-income population vessel owners or crews have been identified, with the possible exception of consolidation of harvest vessels from predominately Alaska Native communities. In the absence of fleet demographic data, it is assumed that local fleet demographics mirror those of the male population of the community in the age bracket corresponding to the overall workforce. It is assumed that there will be job loss among crew positions as consolidation takes place, and it is assumed that in vessels from Alaska Native communities, these positions would be filled primarily by Alaska Natives. However, owners and skippers are also assumed to be Alaska Natives, and these positions would benefit under this alternative. (Further, there is no indication that these impacts would disproportionately accrue to Alaska Native individuals compared to the universe of crew members.) As a result, the net impact in environmental justice terms is unknown and as such, cannot be characterized as high and adverse with existing information.

Individual fishing quota alternative

Environmental justice concerns associated with the fleet would be the same under the IFQ alternative as seen under the three-pie alternative.

Cooperative alternative

Environmental justice concerns associated with the fleet would be the same under the cooperative alternative as seen under the three-pie (and IFQ) alternative(s).

4.7.2.3 Catcher processor-related environmental justice impacts

Status quo alternative

Little is known about the demographics of the crab C/P sector. Under the status quo alternative, no potential high and adverse impacts to minority populations or low-income populations associated with C/P owners or crews have been identified. Therefore, this is not considered to be an environmental justice issue under this alternative.

Three-pie voluntary cooperative alternative

Under the three-pie alternative, no potential high and adverse impacts to minority populations or low-income populations associated with C/P owners or crews have been identified. This sector is largely associated with the community of Seattle, with a small presence in Kodiak. While little is known about the demographics of this sector, it may be assumed to reflect a combination of harvest and processor demographics from other sectors. If this is the case, the crew positions are likely to reflect the demographics of the male workforce of the home port community, while processing positions may be assumed to be disproportionately held by minority individuals recruited out of relatively large communities. While there may be some consolidation and job loss under this alternative, the numbers involved are relatively small compared to other sectors, and there is no indication that they would disproportionately accrue to minority or low-income populations. Therefore, this is not considered to be an environmental justice issue under this alternative.

Individual fishing quota alternative

Environmental justice concerns associated with the C/P sector would be the same under the IFQ alternative as seen under the three-pie alternative.

Cooperative alternative

Environmental justice concerns associated with the C/P sector would be the same under the cooperative alternative as seen under the three-pie (and IFQ) alternative(s).

4.7.2.4 Shore processor-related environmental justice impacts

Status quo alternative

Under the status quo alternative, no potential high and adverse impacts to minority populations or low-income populations associated with processors have been identified. Therefore, this is not considered to be an environmental justice issue under this alternative.

Three-pie voluntary cooperative alternative

Under the three pie alternative, no potential high and adverse impacts to minority populations or low-income populations associated with processors have been identified. Although some seasonal positions (assumed to be disproportionately held by minority individuals based on sector demographics) may be lost with the slowing down of the race for fish, this same situation may result in more longer-term jobs or somewhat fewer, but more stable, remaining jobs. Therefore, this is not considered to be an environmental justice issue under this alternative.

Individual fishing quota alternative

Under the IFQ alternative, processors would not receive quota share and would theoretically have less control over the consolidation that would likely occur under rationalization than would be the case under the three-pie alternative. If some processing firms ceased operations under these conditions, the accompanying job losses would likely trigger environmental justice concerns, but the degree of consolidation in relation to that likely under the three-pie alternative is unknown.

Cooperative alternative

Environmental justice concerns associated with the shore processing sector would be the same under the cooperative alternative as seen under the IFQ alternative.

4.7.2.5 Community development quota-related environmental justice impacts

Status quo alternative

No significant impacts to the CDQ region are anticipated under the status quo alternative. The fishery would continue to operate under the existing conditions system, whereby the CDQ crab fishery operates on a set-aside quota separate and apart from the race-for-fish portion of the quota pursued during the regular BSAI crab fisheries. As a result, CDQ groups receive returns that are proportionately greater than those seen in the regular fishery.

Three-pie voluntary cooperative alternative

Under the three-pie alternative, CDQ crab reserves would be increased from 7.5 percent to 10 percent. This would be a beneficial impact to minority populations and low-income populations. No high and adverse impacts to minority populations or low-income populations are anticipated to occur as the result of other provisions of this alternative. The only identified potential adverse impact would be a relative decrease in the value of CDQ crab in a rationalized fishery. That is, as the entire fishery rationalizes, CDQ crab does not have the additional attraction of being the only rationalized portion of a fishery otherwise structured for a race for fish. It is not possible to quantify the potential impact of this structural change vis-a-vis the rest of the fishery at this point, however, as the economic benefits that will extend to the fishery as a whole under rationalization may result in net benefits to CDQ participants as well (i.e., increased market prices may make up for the incremental advantage over the rest of the fishery lost during rationalization).

Individual fishing quota alternative

Direct impacts to the CDQ program would be beneficial under this alternative as CDQ quota increases would be identical to those seen under the three-pie alternative.

Cooperative alternative

Direct impacts to the CDQ program would be beneficial under this alternative as CDQ quota increases would be identical to those seen under the three-pie alternative.

4.8 Energy requirements and conservation potential of alternatives

For each fishery target, there are energy costs associated with traveling, finding, catching, processing, and delivering the available quota. This cost can be expressed as an energy use per ton of processed product and is a measure of the energy efficiency of the fishery. The energy efficiency varies extensively between target species, gear types, and areas and is primarily a function of the following factors:

- travel distance;
- catch per unit effort;
- vessel capacity;
- gear type; and
- vessel displacement and available horsepower.

The total energy cost for a given fishery is the energy efficiency multiplied by the tonnage harvested, and fisheries management decisions that affect the amount of quota available for harvest will directly affect the total amount of energy required to harvest that quota. Thus, management regimes that result in lower TACs will result in lowered energy usage for the fishery. However, the energy savings that result from TAC reductions are somewhat illusory because, to the extent that the demand for fish products is inelastic, reducing harvest in one fishery simply serves to increase production in another fishery that may or may not be more energy efficient. On the other hand, fisheries management decisions that affect the dynamics of how a fishery is conducted will directly affect the energy cost per ton for the fishery. Management actions such as area closures and gear restrictions generally decrease energy efficiency for the managed fishery. Conversely, energy efficiency can be increased by closing distant fishing grounds or restricting fishing to areas with large concentrations of target species.

There is insufficient data to perform a quantitative analysis of the energy costs associated with BSAI crab fisheries. However, data exists to perform qualitative analysis of predicted changes in energy consumption between the status quo and Alternatives 2, 3, and 4.

The objective of Alternatives 2, 3, and 4 is to increase the long-term socioeconomic benefits of the BSAI crab fisheries. Under these Alternatives, NOAA Fisheries would expand the use of rights based fisheries management through increased reliance on IFQs, PQs, and cooperative programs. Because total harvest under these alternatives would not be expected to change significantly for most species, total fuel consumption would be expected to be similar to Alternative 1. Travel distance would be similar under all alternatives because fishermen travel to where the crab are most abundant. The gear used will be the same under all alternatives. However, some gains in fuel conservation may occur under Alternatives 2, 3, and 4. Alternatives 2, 3, and 4 are predicted to increase CPUE because fishermen will have more time to allow gear to soak on the bottom. Vessel capacity is predicted to change under these alternatives as excess capacity leaves the fishery and harvest effort is concentrated on fewer vessels. Most likely, the remaining vessels would not increase in horsepower since there is no longer a race to fish. In a rights-based fishery, fishermen are generally unable to increase their profit by increasing harvest and must focus on decreasing costs and increasing product value. To some extent, efforts to decrease costs will reduce fuel consumption. However, efforts to increase product value could increase fuel consumption as fishermen seek to optimize product quality.

4.9 Cumulative effects analysis

4.9.1 Introduction to cumulative effects analysis

NEPA requires environmental impact studies to evaluate not only the direct and indirect effects of the proposed action, but also the incremental contribution that action makes to the overall impacts on affected resources from all sources. The requirement to consider cumulative effects on environmental quality was included in the 1978 CEQ regulations, which led to the development of the CEQs cumulative effects handbook (CEQ 1997) and federal agency guidelines based on that handbook (e.g., EPA 1999).

The CEQ regulations for implementing NEPA define cumulative effects as:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7)."

The concept behind cumulative effects analysis is to capture the total effects of many actions over time that would be missed by evaluating each action individually. At the same time, the CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action from every conceivable perspective but to focus on those effects that are truly meaningful. This section analyzes the potential direct and indirect effects of the BSAI king and Tanner crab fisheries, as managed under the proposed EIS alternatives, with factors external to the crab fisheries that affect the physical, biological, and socioeconomic resource components of the BSAI environment. Although predictions of synergistic effects from multiple sources are inherently less certain than predicted effects of individual actions, cumulative effects analyses are intended to alert decision-makers to potential "hidden" consequences of the proposed actions.

To be reliable, any cumulative effects analysis must use a procedure that is (1) logical and methodical, and (2) transparent and reproducible. The CEQ (1997) has established eight principles that were used to guide the analysis of potential effects associated with the alternatives proposed in this EIS:

1. Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions.
2. Cumulative effects are the total effect, including both direct and indirect effects, on a given resource, ecosystem, and human community of all actions taken, no matter who (federal, nonfederal, or private) has taken the actions.
3. Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, and human community being affected.
4. It is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful.
5. Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries.
6. Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects.

7. Cumulative effects may last for many years beyond the life of the action that caused the effects.
8. Each affected resource, ecosystem, and human community must be analyzed in terms of its capacity to accommodate additional effects, based on its own time and space parameters.

The CEQ guidelines can be classified into four basic stages: scoping, organizing, screening, and evaluating. The CEQ emphasizes that the guidelines are intended to "assist practitioners in developing their own study-specific approaches". The approach developed for this cumulative effects analysis is consistent with these guidelines and is outlined below:

Scope: The species, resources, and socioeconomic characteristics covered in this analysis are those that have been identified as having direct or indirect interactions with the BSAI king and Tanner crab fisheries as described in Sections 4.1 through 4.6 of this document. For most resources, the geographic scope is limited to the waters and communities of the BSAI out to the boundaries of the U.S. EEZ. For some species, such as migratory birds, mammals, and fish, the geographic scope of the analysis has been extended to encompass important external factors that potentially affect the status of those species in the BSAI. The socioeconomic analysis includes harvesters, processors, and communities that participate in Bering Sea crab fisheries. These participants are located in Alaska, Washington, and Oregon. The time period considered also varies by species and resource depending on the importance of past events to its present status and the availability of pertinent data.

Organization: The resource categories analyzed for cumulative effects follow the same order considered in the direct/indirect effects of the crab fisheries and include crab, other benthic species and habitat, marine mammals, seabirds, water quality, the BSAI ecosystem, and the human environment. Sub-categories within each of these resource groups also follow the order of presentation in the direct/indirect effects sections. The baseline conditions for each of these resources are described or incorporated by reference in Chapter 3 and reflect their status as of the year 2003 (or as recently as data are available). The types of effects considered parallel the direct/indirect effects but are broadened in some cases to include similar effects from external sources (e.g., incidental take of marine mammals in crab fishing gear is analyzed in conjunction with direct mortality from all sources in the cumulative effects analysis, including subsistence hunting). Reasonably foreseeable future events are identified for each resource category according to the potential for these events to contribute to the effects selected for analysis. The external events considered were determined by reviewing relevant Environmental Impact Statement, reports and resource studies, peer-reviewed literature, and information from expert contributors. External factors include both human-caused and natural events.

The analyses are presented in text and table formats to facilitate the needs of the reader. The tables summarize the information presented in the text and are intended to provide an overview of the key issues. For each resource sub-category (ie. species or economic sector), the identified effects are analyzed separately. The predicted contribution of the crab fisheries to that effect is considered in the context of all the other reasonably foreseeable human and natural events that contribute to the effect. In both text and table formats, the information is presented in the following order: direct/indirect effects of the crab fisheries and their significance, persistent past effects (from the baseline description in Section 3.5), reasonably foreseeable future external events, and the cumulative condition of the resource and the significance of the incremental contribution of the proposed action to the cumulative condition. If there are differences between the EIS alternatives for a particular effect, the significance ratings for each alternative are listed separately and the implications for the cumulative effects analysis are noted where appropriate.

Screening: The initial screening of resource categories and effects to be considered takes place during the scoping process for the EIS. The cumulative effects analysis considers the same resource categories and effects as the direct/indirect effects analysis but expands the considerations to external events. However, not all external events affect a given resource in all the ways the fishery might. If there is no plausible mechanism for an event to have a cause-and-effect influence on the given resource for a particular effect type, it is labeled as "not a contributing factor". If there is a plausible mechanism for an effect, even if it is insignificant on its own, the event is considered to have a "potentially adverse or beneficial contribution".

Evaluating: The last step is to determine the overall cumulative condition of the resource, the significance of the contribution of the proposed action to the cumulative condition, and to explain the rationale for how the conclusion was reached. The cumulative effects significance ratings follow the criteria established in the direct/indirect effects analysis for each resource. Significance conclusions are the estimated incremental effect of the proposed action on the resource given the resource condition resulting from past, present, and reasonably foreseeable future actions. Ideally, these criteria are based on measurable or quantitative differences between the resource as influenced by the crab fisheries and a baseline condition or objective standard. Depending on the resource and type of effect being considered, these criteria might be based on population level changes for a given species, a fisheries management goal such as MSST, or a socioeconomic measure such as ex-vessel value of a harvest. In some cases, the effects cannot be measured quantitatively so the significance criteria are more qualitative in nature. If not enough information is available to assess whether an effect is "significant" or "insignificant" under the specified criteria, that effect may be labeled "unknown". The rationale for each conclusion includes the key factors or events that cause an overall effect on the resource, the uncertainties involved in the prediction, or an explanation of what information is lacking that prevents a significance determination.

The cumulative effects approach developed for this EIS follows CEQ guidelines and is intended to provide the reader with the information necessary to make an informed and independent judgment concerning the validity of the conclusions. This analysis is also intended to assist decision-makers in identifying broader issues of concern relating to the proposed actions.

4.9.2 Cumulative effects analysis for crab

For this analysis, the cumulative effects of the BSAI Crab fisheries under status quo and the proposed alternative rationalization programs for the biological environment are discussed together. None of the alternatives considered, status quo or alternative rationalization programs, would result in changes to harvest levels or harvest-setting processes for any of the crab stocks. In addition, none of the proposed alternatives would change the stock assessment process used for setting harvest limits. Thus, the biological effects among alternatives are similar and the cumulative effects indistinguishable. The primary difference among the alternatives for biological effects is the potential temporal dispersion of the fisheries under rationalization. However, possible environmental effects resulting from redistribution of the fisheries over time is difficult to determine since the timing and location of fishing is at the discretion of fisherman as driven by the market. Potential effects of obtaining either the GHL or TAC for a specific crab stock are assumed to be the same, regardless of whether the catch occurs under the status quo management program or one of the alternative rationalization programs.

The baseline conditions for the BSAI crab stocks have been described, to the extent that they are known, in Sections 3.2 and 3.5. The direct/indirect effects of the BSAI king and Tanner crab fisheries on the life stages of these species and habitat have been analyzed in Section 4.2. The cumulative effects analyses for all alternative rationalization programs are summarized in Tables 4.9-1 through 4.9-8.

Western Alaska king crab stocks, Tanner crab, and snow crab fisheries are managed by the State, with federal oversight and following guidelines established in the BSAI king and Tanner crab FMP (NPFMC 1998). King crab, along with Tanner crab and snow crab, are prohibited species in State scallop and groundfish fisheries, and in Federal groundfish fisheries. This means that any crab bycatch must be discarded. Trawl fishery regulations focus on concerns for direct impacts to crab populations by trawling, considered trawl-induced mortality, and indirect impacts through habitat degradation. Because bycatch mortality in the trawl fisheries is currently considered to be minor relative to other sources of mortality for crab, temporal and spatial closures are thought to be more effective than PSC limits in reducing impacts of trawling on crab stocks (Witherell and Harrington 1996). As such, numerous trawl closure areas have been instituted to address concerns about unobserved mortality (crab wounded or killed but not captured), and possible habitat degradation resulting from bottom trawling and dredging.

Section 3.5 summarizes the past and present external effects on BSAI crab stocks and the current baseline condition for each.

Direct and indirect effects

Direct/indirect effects of the Proposed Action for all species of crab include changes in mortality, habitat, and reproductive success (see Sections 4.2.1 and 4.2.2 for further detail regarding potential effects on different life stages of crab). These effects may be attributed to fishing activities, but may also be linked to natural events such as long-term climatic change and decadal regime shifts.

Mortality

Fishery sources of legal male mortality: Increased mortality of legal males can occur when harvest exceeds the GHL as a result of derby-style fishing. Seasons are difficult to close quickly when the lower pre-season targets are exceeded and a large efficient fleet can quickly over harvest crab if the concentration of crab are high. Highgrading the larger and cleaner males and discarding other legal males to increase the value of the catch also results in mortality of the crab that are returned to the water. Deadloss at the dockside, estimated at approximately 1 to 2 percent of the total harvest, is not a problem since it is accounted for in the GHL. However, if discarded at sea and not accounted for, deadloss can have a negative effect on crab populations since it is not accounted for in the GHL.

Fishery sources of female and sub-legal crab mortality: Females and sub-legal crabs are brought up in the pots with legal males; this bycatch accounts for up to two thirds of the total catch. The mortality from handling and discarding these crab is estimated at up to 25 percent and, therefore, is a large source of mortality for this segment of the population.

Stock rebuilding: Stock rebuilding can have positive effects on mortality of legal males, sub-legal males, and female crab in the population by implementing conservative harvest strategies.

Non-target crab mortality from fisheries: Non-target crab species are also caught in pot gear along with the targeted species. The handling and discards of these individuals also results in increased mortality of those caught.

Harvest Methods: Harvest timing (length of season, time of year, weather), fishing effort (amount of gear), and the ways in which crab are handled on deck, all contribute to the mortality rate of crab.

Reproductive success

Changes in reproductive success of crab stocks affect abundance levels, and fisheries can affect reproductive success by causing changes in the ratio of males to females, size of male crab, and the genetic diversity by reducing population size and/or eliminating segments (sex and age classes) of a population. From the information available, it is not possible to determine whether or not the crab fisheries affect the genetic structure of crab populations. Therefore, further research and analysis is necessary to determine if the crab fisheries affect the genetic structure and whether or not this effect is significant.

Habitat

Since crab live on the sea floor, adverse effects to their benthic habitat could potentially impact the abundance of the crab stocks. Effects of the crab fisheries on benthic habitat are generally considered insignificant; however, the effects on habitat from other fisheries and subsequent effects on crab are not well understood and the potential significance of these effects has not been determined.

Cumulative effects analysis

Summaries of the cumulative effects analyses for status quo and proposed alternative rationalization programs are shown in Tables 4.9-1 through 4.9-8.

Cumulative effects analyses for BSAI crab stocks are presented in the following order:

- Pribilof Islands red king crab
- Aleutian Islands red king crab
- Bristol Bay red king crab
- Bering Sea blue king crab (St. Matthews and Pribilof Islands)
- Bering Sea golden king crab
- Aleutian Islands golden king crab
- BSAI Tanner crab
- Bering Sea snow crab

Pribilof Islands red king crab

<u>Mortality</u>

- ***Direct and indirect effects of the proposed action.*** Direct/indirect effects on crab mortality are discussed in Section 4.2.2. Overall, none of the alternatives would affect total removals of crab or change current closures and harvest level-setting processes. Thus, potential effects of the status quo and alternative rationalization programs on mortality of legal males, sub-adult males, adult females, and non-target crab are considered insignificant.

- ***Past actions with persistent effects.*** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960's in order to reduce gear conflicts and allocate crab resources between domestic 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. Crab bycatch has also occurred in foreign and JV groundfish trawl fisheries, federal and state-managed bottom trawl, pot, hook and line fisheries, and halibut fisheries. However, bycatch of Pribilof Islands red king crab in these fisheries has declined since 1995 when the Council established the Pribilof Islands Habitat Conservation Area, a year-round no-trawl closure. Since 1999, red king crab abundance has been increasing in this region. However, the directed fishery is closed due to concerns with bycatch of blue king crab. Lingering adverse past effects of mortality on crab stocks from directed crab catch and bycatch may still persist. Changes in water temperature and currents could exert positive or negative effects on direct mortality, and lingering effects from past climate events could still exist.

- ***Reasonably foreseeable future external actions.*** Bycatch of Pribilof Islands red king crab will continue in the federal groundfish fisheries that operate near the Pribilofs, but outside of the closed area. Chronic environmental pollution and contamination from multiple sources could potentially occur throughout this region. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. Contamination of essential habitat may result in population-level effects on crab. The role of environmental contamination and persistence of pollutants in changes to crab abundance has not been studied, so effects associated with these pathways are unknown. Fluctuations in crab populations have occurred over time, and environmental factors very likely play a role in these fluctuations. Climatic variability will continue to exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant. The directed fishery has been closed since 1999. Rationalization of the fisheries could result in redistribution of fishing effort over time and allow boats to concentrate on crab aggregations. This may also allow for longer pot soaking time, minimizing handling/sorting mortality and decreasing bycatch of females and sub-legal males. In addition, rationalization promotes better communication among vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered, thus further reducing bycatch of these crabs. External effects of bycatch mortality in the groundfish fisheries are a major contribution to the overall mortality of crab. Overall, the cumulative condition of red king crab stocks in this region is characterized by increases in abundance with fluctuations still occurring. The overriding influence of climate and oceanographic changes on crab mortality contributes to the uncertainty in determining the significance of a cumulative effect resulting from past actions, internal crab fishery activities, and reasonably foreseeable future external actions.

<u>Changes in habitat</u>

- ***Direct and indirect effects of the proposed action.*** Based on the relatively small areas that are impacted by pot gear in the red king crab fisheries, and the fact that living habitats extend both inshore and seaward of the fishery impact zone, the Pribilof Islands red king crab fisheries are considered to have insignificant effects on benthic habitat. Since the status quo and alternative rationalization programs would not change current closures or harvest levels, this conclusion applies to all proposed alternatives. Effects of pot gear on living and non-living substrate are discussed in Section 4.9.3.

- ***Past actions with persistent effects.*** Setting and retrieval of pot gear can damage bottom habitat and fisheries-related effects on benthic habitat have occurred from foreign and domestic crab fisheries. Bottom trawling associated with past foreign and domestic groundfish fisheries has directly impacted benthic habitat and other marine substrates used by crab the Pribilof Islands. Since 1995, the majority of red king crab habitat has been protected by the Pribilof Islands Habitat Conservation Area. Adverse past effects on crab habitat from these fisheries could still persist in some areas although it has not been well documented.

- ***Reasonably foreseeable future external actions.*** Benthic habitat of red king crab will continue to be affected by Federal trawl and pot groundfish fisheries in the region, outside of the Pribilof Islands Habitat Conservation Area. Chronic environmental pollution and contamination from multiple sources could potentially occur throughout this region. Additionally, contamination of essential habitat could cause population level effects on crab. Climatic variability is not expected to result in changes to physical habitat.

- ***Cumulative effect***. Bottom trawling in the groundfish fisheries can affect benthic habitat through physical disruption of substrates and could potentially have substantial effects on crab habitat (Section 4.9.3). However, the majority of the red king crab habitat is protected from trawling by the

Pribilof Islands Habitat Conservation Area. . Although the incremental contribution of this fishery to the overall cumulative effect status of this stock is insignificant, the cumulative condition resulting from changes to red king crab habitat by past events, internal crab fishery activities, and reasonably foreseeable future external events is unknown. This conclusion is the same for the status quo and alternative rationalization programs.

Change in reproductive success

- ***Direct and indirect effects of the proposed action.*** Fisheries can impact a stock's reproductive success by changing the ratio of males to females in the population and causing a decrease in the average size of male crabs in the population. Overall, the fluctuating abundance of these stocks is directly related to the reproductive success. The reasons for the fluctuation in stock abundance are not well understood nor are the fisheries-related effects on these fluctuations. Lacking the ability to determine how fisheries influence changes in reproductive success, the significance of potential effects under the status quo or the alternatives rationalization programs cannot be determined with certainty. However, the conservative harvest strategies are applied to the crab stocks to prevent the fisheries from significantly impacting the reproductive success of the stock. Therefore, the crab fisheries are presumed to have an insignificant effect on reproductive success.

- ***Past actions with persistent effects.*** Past fisheries may have indirectly impacted reproductive success of some crab populations by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Effects from disruption of spawning aggregations by past directed fishing and trawl bycatch may still persist. highgrading of legal males and removal of mature males via crab fisheries could alter the sex ratio within the population and have lingering effects on reproductive and recruitment success.

- ***Reasonably foreseeable future external actions.*** Bycatch of adult crab or damage to spawning or nursery habitat by groundfish trawl and pot fisheries could impact reproductive success within crab populations. Chronic environmental pollution and contamination from multiple sources could potentially occur throughout this region. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. Contamination of essential habitat could cause population-level effects on crab. The role of environmental contamination and persistence of pollutants in changes to crab abundance and annual recruitment has not been studied, so chronic effects associated with these pathways are unknown. Fluctuations in crab populations have occurred over time and environmental factors very likely play a substantial role in these fluctuations. Climatic variability will likely continue to exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** Highgrading of legal males is a concern since these crab are considered most successful at mating. Removal of mature males could alter the sex ratio within the population but potential effects are unknown. Disruption of spawning aggregations by fishing could lead to reduced recruitment. Under the proposed alternative rationalization programs, temporal redistribution of fishing effort could allow for longer pot soaking time which may minimize handling/sorting mortality and decrease bycatch of females and sub-legal males. These programs may also promote better communication among vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered as to minimize bycatch and mortality of these crabs. However, potential effects of the BSAI crab fisheries on reproductive success under the status quo and alternative rationalization programs are insignificant because the harvest strategies will not change under the alternatives. . Therefore, the potential cumulative effect resulting from past events, internal fishing activities, and reasonably foreseeable future external events, would be unknown.

Aleutian Islands red king crab

Mortality

- ***Direct and indirect effects of the proposed action.*** Indicators of crab mortality in the crab fishery are discussed in Section 4.2.2. Overall, none the alternatives would affect total removals of crab or change current closures and harvest level-setting processes. There is a small fishery for Aleutian Islands red king crab with a 2002 GHL of 0.5 million pounds (Section 3.5.3). Potential effects of the status quo and the alternative rationalization programs on mortality of legal males, sub-adult males, adult females, and non-target crab, are considered insignificant.

- ***Past actions with persistent effects.*** Direct catch and bycatch of Aleutian Islands red king crab are associated with past foreign, JV, and domestic fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960's in order to reduce gear conflicts and allocate crab resources between domestic 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. Effects of the Federal trawl groundfish fisheries on this stock are less likely than those identified for other red king crab stocks due to their rough bottom terrain habitat, which is less favorable for trawling. A directed fishery has existed since 1961 and peak harvests occurred in the mid-1960's. Dutch Harbor stocks declined and fisheries have been closed annually since 1982. The Adak fishery closed in 1995 and since then, fishing has only occurred during the 1998 season. Eastern Aleutian Islands stocks are considered severely depressed. Thus, adverse past effects of mortality on these crab stocks from directed crab catch and bycatch may still exist.

- ***Reasonably foreseeable future external actions.*** Alaska scallop fisheries do not occur in the Aleutian Islands and are not considered contributing factors in crab mortality in this region. Bycatch of crab in Federal groundfish trawl and pot fisheries do occur, but at a low level. Chronic environmental pollution and contamination from multiple sources could potentially occur throughout this region. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. Contamination of essential habitat could result in population-level effects on crab. The role of environmental contamination and persistence of pollutants in changes to crab abundance has not been studied, and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant. Most of the fisheries in this area remain closed and the proposed action would not result in significant beneficial or adverse changes to the baseline condition for these stocks. Despite recent signs of recovery in western Aleutian Islands stocks, the lack of complete recovery in these crab stocks is still apparent.

  The possible redistribution of fishing effort that may result from the proposed rationalization programs could also allow for longer pot soaking time, minimizing handling/sorting mortality and decreasing bycatch of females and sub-legal males. If stocks recover and fishing resumes, rationalization programs may promote better communication between vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered, thus reducing bycatch of these crabs. External effects of bycatch in groundfish fisheries on overall mortality of crab are considered major contributors to the cumulative condition of these stocks. In addition, the overriding influence of climate and oceanographic changes on crab abundance contributes to this condition.

Changes in habitat

- ***Direct and indirect effects of the proposed action.*** Based on the relatively small areas that are impacted by pot gear in the Aleutian Islands red king crab fisheries, and the fact that crab habitat areas extend both inshore and seaward of the fishery impact zone, the Aleutian Islands king crab fisheries are considered to have insignificant effects on benthic habitat. None of the alternatives would affect total removals of crab or change current closures and harvest level-setting processes. Specific effects of pot gear on living and non-living substrate are discussed in Section 4.9.3.

- ***Past actions with persistent effects.*** Setting and retrieval of crab pots can damage habitat. Bottom trawling associated with past foreign and domestic fisheries has directly impacted benthic habitat and other marine substrates used by crab in certain areas of the Aleutian Islands. This is likely less of a factor in the Aleutian Islands compared to other areas due to the large area of habitat that is unfavorable for trawling. However, adverse past effects on crab habitat from these fisheries could still persist in some areas.

- ***Reasonably foreseeable future external actions.*** Potential impacts to crab habitat by groundfish trawl fisheries have been identified in some areas of the Aleutian Islands but the significance of these events to crab populations is difficult to determine. Thus, potential impacts to crab habitat could occur. Chronic environmental pollution and contamination from multiple sources could potentially occur throughout this region. Contamination of essential habitat could cause population level effects on crab. Climatic variation and regime shift is not expected to result in significant changes to benthic habitat.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant. Most of the fisheries in this region are closed and minimal overlap between trawling and crab habitat exists in the Aleutian Islands. Distribution of this population extends into depths greater than those fished and it is not clear if habitat in shallow areas is impacted by current fishing practices or still experiencing impacts from past effects. Little is known about the baseline habitat conditions in this area and the overall cumulative condition resulting from past actions, internal fishery activities, and reasonably foreseeable future external actions, is largely unknown.

Change in reproductive success

- ***Direct and indirect effects of the proposed action.*** Indicators of reproductive effects in the BSAI crab fisheries are discussed in Section 4.2.2. Fisheries can impact the reproductive success of crab stocks through the removal of mature males, thereby changing the ratio of males to females in the population and causing a decrease in the average size of male crabs in the population. Overall, the fluctuating abundance of these stocks is directly related to the reproductive success. However, the nature of this relationship has not been defined and the effects that fisheries have on these fluctuations, by removing mature males from the population or impacting sub-adult males and females through bycatch, have not been characterized. Lacking the ability to determine how fisheries influence changes in reproductive success, the significance of potential effects under the status quo or the alternative rationalization programs cannot be determined with certainty. However, the conservative harvest strategies are applied to the crab stocks to prevent the fisheries from significantly impacting the reproductive success of the stock. Therefore, the crab fisheries are presumed to have an insignificant effect on reproductive success.

- ***Past action with persistent effects.*** Past foreign, JV, and domestic fisheries may have indirectly impacted reproductive success of crab populations by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Effects from disruption of spawning aggregations by past crab and groundfish bottom trawl fisheries may still persist. Highgrading of legal males and removal of mature males in crab fisheries could have altered the sex ratio within the population, thus exerting lingering effects on reproductive and recruitment success.

- ***Reasonably foreseeable future external actions.*** Bycatch of adult crab or damage to spawning or nursery habitat by groundfish fisheries could impact reproductive success within crab populations. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance and annual recruitment has not been studied and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant because conservative harvest strategies prevent impacts to reproductive success. Under the proposed alternative rationalization programs, temporal redistribution of fishing effort could allow for longer pot soaking time, minimizing handling/sorting mortality, and decreasing bycatch of females and sub-legal males. These programs may also promote better communication among vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered, further reducing bycatch and mortality of these crabs. However, the cumulative condition resulting from past actions, internal fishing activities, and reasonably foreseeable future external actions, remains undetermined until a baseline condition is established for these crab stocks.

Bristol Bay red king crab

Mortality

- ***Direct and indirect effects of the proposed action.*** Indicators of crab mortality in the crab fishery are discussed in Section 4.2.2. Overall, none of the alternatives would affect total removals of crab or change current closures and harvest level-setting processes. Thus, effects of the status quo and the alternative rationalization programs on mortality of legal males, sub-adult males, females, and non-target crab populations are considered insignificant.

- ***Past actions with persistent effects.*** Direct catch and bycatch of crab are associated with past foreign, JV, and domestic fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960's 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. A directed fishery for Bristol Bay red king crab has existed since 1968 and peak harvest levels occurred in 1980, but by 1983, the fishery was closed due to record lows in the king crab populations (Section 3.5.3). After 1983, stocks fluctuated, fisheries occurred, but declines in abundance were still apparent. The fishery continued at reduced levels until 1993 and the fishery was once again closed during the 1994 and 1995 seasons. The fishery was re-opened in 1996 with a conservative harvest rate due to low abundance. Bristol Bay red king crab abundance has increased since then, however, it remains below the historic high abundance seen in the 1970's. GHL limits have been exceeded during past fishing seasons which may impact stock sustainability over time (Section 3.5.3). Despite the recent increases in abundance estimates, adverse past effects of mortality on crab stocks from directed crab catch and bycatch could still persist but population-level impacts have not been determined.

- ***Reasonably foreseeable future external actions.*** Alaska scallop fisheries catch Bristol Bay red king crab as bycatch, however, their contribution is considered negligible when compared to bycatch potential in federal groundfish fisheries. Bycatch in the groundfish trawl fisheries has been reduced since the establishment of the Red King crab Savings Area in 1995 and the Nearshore Bristol Bay Closure Area in 1996, which closed crab habitat to bottom trawling. Bycatch of crab is expected to continue in these fisheries and could increase if elimination or redistribution of current protection areas and no-trawl zones occurred. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance has not been studied, and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant. Although stocks are currently considered stable, they still exhibit fluctuations in abundance. The possible redistribution of fishing effort resulting from rationalization programs could allow for longer pot soaking time which may minimize handling/sorting mortality and decrease bycatch of females and sub-legal males. In addition, rationalization programs promote better communication among vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered, further reducing bycatch potential of these crabs.

Changes in habitat

- ***Direct and indirect effects of the proposed action.*** Based on the relatively small areas that are impacted by pot gear in the red king crab fishery, the potential impacts to benthic habitat by this fishery is considered insignificant. None of the alternative rationalization programs would affect total removals of crab or change current closures and harvest level-setting processes. Further discussion regarding potential effects of pot gear on living and non-living substrate is presented in Section 4.9.3.

- ***Past actions with persistent effects.*** Historically, setting and retrieval of pot gear by fisheries may have damaged bottom habitat, but the significance of potential effects to various benthic communities has not been determined. Bottom trawling associated with past foreign, JV, and domestic fisheries has directly impacted benthic habitat and other marine substrates used by crab in certain areas of the BSAI. Thus, adverse past effects on crab habitat from these fisheries could still exist.

- ***Reasonably foreseeable future external actions.*** Potential for spatial overlap between scallop fisheries and crab habitat in this region exists, but is considered negligible based on the small number of fishing vessels currently participating in the fishery. Significant impacts to crab habitat by groundfish fisheries are difficult to determine but could occur. Thus, potential impacts to crab habitat may occur as these fishing activities continue over time. In addition, environmental contamination impacting essential habitat could result in population-level effects on crab. Climatic variability is not expected to result in changes to physical habitat.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of this stock is insignificant. Thus, the cumulative condition, resulting from past actions, internal fishery activities, and reasonably foreseeable future external actions, is currently unknown.

Change in reproductive success

- ***Direct and indirect effects of the proposed action.*** Fisheries can impact reproductive success of crab stocks through the removal of mature males, thereby changing the ratio of males to females in the population and causing a decrease in the average size of male crabs in the population. Overall, the fluctuating abundance of these stocks is directly related to the reproductive success. The reasons for the fluctuation in stock abundance are not well understood nor are the potential effects that fisheries have on these fluctuations. Lacking the ability to determine how fisheries influence changes in reproductive success, the significance of potential direct/indirect effects cannot be determined with certainty. However, the conservative harvest strategies are applied to the crab stocks to prevent the fisheries from significantly impacting the reproductive success of the stock. Therefore, the crab fisheries are presumed to have an insignificant effect on reproductive success.

- ***Past actions with persistent effects.*** Past foreign, JV, and domestic fisheries may have indirectly impacted reproductive success of some crab populations by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Effects from disruption of spawning aggregations by past crab fisheries and groundfish bottom trawl fisheries may still exist. Highgrading of legal males and bycatch of female and sub-legal males in crab fisheries could alter the sex ratio within the population and have lingering effects on reproductive and recruitment success.

- ***Reasonably foreseeable future external actions.*** Potential effects of bycatch and damage to spawning or nursery habitat by scallop fisheries are considered negligible relative to bycatch in the groundfish fisheries, and are considered contributors to the potential for impacting reproductive success within crab populations. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance and annual recruitment has not been studied and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** Reproductive success influences crab abundance but the nature of this relationship has not been defined and the effects that fisheries have on these fluctuations have not been characterized. However, the incremental effects of the alternatives is considered insignificant because conservative harvest strategies prevent impacts to reproductive success Although this stock is currently considered stable, fluctuations in abundance still occur. Under the alternative rationalization programs, temporal redistribution of fishing effort could allow for longer pot soaking time which may minimize handling/sorting mortality and decrease bycatch of females and sub-legal males. Rationalization programs may also promote better communication among vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered. This could minimize bycatch of these crabs and further reduce mortality.

Bering Sea blue king crab (St. Matthews and Pribilof Islands)

<u>Mortality</u>

- ***Direct and indirect effects of the proposed action.*** Indicators of crab mortality in the crab fishery are discussed in Section 4.2.2. Overall, none of the alternatives would affect total removals of crab or change current closures and harvest level-setting processes. The fishery is closed and rebuilding plans are either in place or in development; therefore, potential effects of the status quo and the alternative rationalization programs on crab mortality are insignificant.

- ***Past action with persistent effects.*** Direct catch and bycatch of crab are associated with past foreign, JV, and domestic fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960's 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. A directed fishery in Pribilof Islands for blue king crab was established in 1973, peaked in 1981, and was closed from 1988-1995. Abundance increased, and the fishery was re-opened in 1996. Abundance declined again in 1999 and the fishery has been closed since then. A directed fishery for blue king crab in the St. Matthew Island area was established in 1977. From 1999 until present, this fishery has remained closed due to a decline in abundance. Stocks are considered overfished, a rebuilding plan is in place for the St. Matthew stock and the Pribilof Islands stock. Even though blue king crab is not a measurable portion of bycatch in any fishery today, adverse past effects of mortality on crab stocks resulting from directed crab catch and bycatch in other fisheries may still persist. A relationship between climatic variability and fluctuating crab stocks has not been defined but may play a role in the current baseline condition of this stock.

- ***Reasonably foreseeable future external actions.*** Scallop fisheries are not considered contributing factors since they do not occur in this region and bycatch of blue king crab has not been reported in this fishery. Blue crab bycatch occurs to a small degree in the Federal pelagic pollock trawl fishery. However, trawling is currently prohibited in State and Federal waters of this region. In the event that current trawling closures in this area are changed or removed, bycatch potential and habitat disruption could increase for blue king crab. Pot gear is used in the Pacific cod fisheries and these fisheries likely contribute to bycatch, although their relative contribution to the overall population-level impact is considered negligible. Chronic environmental pollution and contamination from multiple sources could potentially occur throughout this region. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance has not been studied and potential chronic effects are unknown. Climatic variability can exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant. The fishery remains closed and the proposed action would not result in significant beneficial or adverse changes to the baseline condition of these stocks. Blue king crab stocks in this region are considered overfished and recovery has not been shown to have occurred to date. If the stocks recover and fishing resumes, rationalization may promote better communication between vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered, thus reducing bycatch of these crabs.

Changes in habitat

- ***Direct and indirect effects of the proposed action.*** Habitat for the blue king crab occurs around the Pribilof Islands, St. Matthew Island, and St. Lawrence Island. Protected areas have been established around the Pribilof Islands and St. Matthew Island to protect blue king crab and their habitat. Nominal commercial fishing occurs around St. Lawrence Island. Based on the relatively small areas that are impacted by pot gear in the blue king crab fisheries, potential effects to benthic habitat by these fisheries are considered insignificant. Specific cumulative effects of pot gear on living and non-living substrate are discussed in Section 4.9.3.

- ***Past actions with persistent effects.*** Setting and retrieval of pot gear in past fisheries may have damaged or destroyed crab habitat but the significance of these effects on benthic communities, including crab, has not been determined. Bottom trawling associated with past foreign, JV, and domestic fisheries has directly impacted benthic habitat and other marine substrates used by crab in the St. Matthew Islands and Pribilof Islands areas. Adverse past effects on crab habitat from these fisheries could still persist.

- ***Reasonably foreseeable future external actions.*** In the event that current closures, such as the Pribilof Islands Habitat Conservation Area (no-trawling), are changed or eliminated, the potential for habitat impacts to occur increases. Chronic environmental pollution and contamination from multiple sources could potentially occur throughout this region and could cause population-level effects on crab. Climatic variability is not expected to result in changes to physical habitat.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant. The fishery remains closed and large areas of blue king crab habitat have been protected from impacts by trawl fisheries. Thus, the proposed action would not result in significant beneficial or adverse changes to the baseline condition of these stocks. Persistent past effects have not been characterized to date and it is not clear if habitat in shallow areas is impacted by current fishing practices.

<u>Change in reproductive success</u>

- ***Direct and indirect effects of the proposed action.*** Indicators of reproductive effects in the BSAI crab fisheries are discussed in Section 4.2.2. Fisheries can impact reproductive success of crab stocks through the removal of mature males, thereby changing the ratio of males to females in the population and causing a decrease in the average size of male crabs in the population. Overall, the fluctuating abundance of these stocks is directly related to their reproductive success. However, the nature of this relationship has not been defined and the effects that fisheries have on these fluctuations, by removing mature males from the population or impacting sub-adult males and females through bycatch, have not been characterized with certainty. However, the conservative harvest strategies are applied to the crab stocks to prevent the fisheries from significantly impacting the reproductive success of the stock. Therefore, the crab fisheries are presumed to have an insignificant effect on reproductive success.

- ***Past actions with persistent effects.*** Past foreign, JV, and domestic fisheries may have indirectly impacted reproductive success of blue king crab populations by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Effects from disruption of spawning aggregations by past crab and groundfish bottom trawl fisheries may still persist. Highgrading of legal males and removal of mature males via crab fisheries could alter the sex ratio within the population, thus exerting lingering effects on reproductive and recruitment success.

- ***Reasonably foreseeable future external actions.*** Currently, State and Federal waters of this region are closed to trawling. However, bycatch of adult crab or damage to spawning or nursery habitat in groundfish pot fisheries could potentially impact reproductive success within blue king crab populations. Chronic environmental pollution and contamination from multiple sources could potentially occur throughout this region. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance and annual recruitment has not been studied, so chronic effects associated with these pathways are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks are insignificant because conservative harvest strategies prevent impacts to reproductive success. Reproductive success influences stock abundance and blue king crab stocks in this region are considered overfished. If these stocks recover and fishing resumes, alternative rationalization programs may promote communication among vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered, thus minimizing bycatch and mortality of these crabs.

Bering Sea Golden king crab

Mortality

- ***Direct and indirect effects of the proposed action.*** Indicators of crab mortality in the crab fishery are discussed in Section 4.2.2. Overall, none of the alternative rationalization programs would affect total removals of golden crab or harvest level-setting processes. Therefore, potential effects on mortality under the status quo and the alternative rationalization programs are considered insignificant**.**

- ***Past actions with persistent effects.*** Direct catch and bycatch of crab are associated with past foreign, JV, and domestic fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960's 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. A directed fishery for Bering Sea golden king crab has existed since 1982. Record catch rates were recorded in 1999. A directed fishery for golden king crab near St. Matthew Island began in 1982 but no harvest has occurred since 1996. No abundance estimates exist for these stocks so population status cannot be determined. Thus, adverse past effects of mortality on crab stocks from directed crab catch and bycatch are unknown.

- ***Reasonably foreseeable future external actions.*** Scallop fisheries are not considered contributing factors in mortality of golden king crab since no bycatch of this species has been recorded. Small amounts of bycatch of golden king crab occur in Federal groundfish trawl fisheries and Pacific cod pot fisheries, and these fisheries could contribute to future bycatch. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance has not been studied and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant. Currently, no abundance estimates exist for these stocks and population status us unknown. Therefore, the cumulative condition cannot be determined until a baseline condition has been established.

Changes in habitat

- ***Direct and indirect effects of the proposed action.*** Based on the relatively small fishery for golden king crab, areas potentially impacted by pot gear would be negligible and potential effects are considered insignificant to benthic habitat. Effects of pot gear on living and non-living substrate are discussed in Section 4.9.3.

- ***Past actions with persistent effects.*** Setting and retrieval of longline pot gear amidst steep bottom topography, characterizing the habitat in which these crab live, could have damaged living and non-living habitat, but the significance of this effect to benthic communities has not been determined. Bottom trawling associated with past foreign, JV, and domestic fisheries has directly impacted benthic habitat and other marine substrates used by crab in certain areas of the Bering Sea . Adverse past effects on crab habitat from these fisheries could still persist.

- ***Reasonably foreseeable future external actions.*** Impacts to golden king crab habitat by Federal and State groundfish fisheries are presumed minimal due to the rough bottom terrain which is not conducive to trawling. Contamination of essential habitat could cause population-level effects on crab. However, climatic variability is not expected to result in changes to physical habitat.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of this stock is insignificant. Distribution of this population extends into depths greater than those fished by groundfish fisheries. Since little is known regarding habitat requirements of these crab, it is not clear if habitat in shallow areas is impacted by current fishing practices or if impacts from past effects still exist. The cumulative condition resulting from past actions, internal fishery activities, and reasonably foreseeable future external action, is difficult to determine in the absence of a baseline condition.

<u>Change in reproductive success</u>

- ***Direct and indirect effects of the proposed action.*** Effects of the BSAI crab fisheries under status quo and the alternative rationalization programs on reproductive success of golden king crab are insignificant (Section 4.2.2). Overall, reproductive success within crab populations is an underlying factor in the fluctuating abundance of these stocks. However, the significance of any fisheries-related effects on reproductive success for golden king crab is not known with certainty. However, the conservative harvest strategies applied to the crab stocks is to prevent the fisheries from significantly impacting the reproductive success of the stock.

- ***Past actions with persistent effects.*** Past foreign, JV, and domestic fisheries may have indirectly impacted reproductive success of crab populations by removing vital brood stocks and/or adversely impacting spawning and nursery habitat. Catches of golden king crab have declined from the early years of the fishery, as the initial stock was exploited and recruitment was unable to sustain the fishery at its initial harvest levels. Thus, effects from past directed fishing may still persist.

- ***Reasonably foreseeable future external actions.*** Bycatch of adult crab or damage to spawning or nursery habitat by groundfish trawl and pot fisheries could impact reproductive success within this crab population. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance and annual recruitment has not been studied and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** Reproductive success influences crab abundance. Within the crab fishery, highgrading and removal of legal males is a concern since these crab are considered most successful at mating. Additionally, disruption of spawning aggregations by fishing activities could lead to reduced recruitment. The incremental contribution of the proposed rationalization programs to the overall cumulative effect status for this stock is presumed to be insignificant because conservative harvest strategies prevent impacts to reproductive success.

Aleutian Islands golden king crab

Mortality

- ***Direct and indirect effects of the proposed action.*** Direct and indirect effects on mortality are discussed in Section 4.2.2. Overall, none of the alternative rationalization programs would affect total removals of crab or change current closures and harvest level-setting processes. The potential effects of the proposed alternatives on crab mortality are considered insignificant.

- ***Past action with persistent effects.*** Direct catch and bycatch of crab are associated with past foreign, JV, and domestic fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960's 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. Prior to 1981, golden king crab were taken as incidental bycatch in other crab fisheries. Bycatch of golden king crab also occurred in groundfish trawl fisheries. A directed fishery for golden king crab has existed since 1981. Based on fishery performance and observer data from 1996 to present, the golden king crab stock in the Aleutian Islands is considered stable and a GHL has been set for areas east and west of 174° W. However, adverse past effects of mortality on crab stocks from directed crab catch and bycatch could still persist.

- ***Reasonably foreseeable future external actions.*** Scallop fisheries do not occur in the Aleutian Islands and bycatch of golden king crab has not been reported. Bycatch will continue to occur in Federal groundfish fisheries, trawl fisheries in State waters, sablefish pot fisheries, and the Pacific cod pot fisheries. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance has not been studied and chronic effects associated with these pathways are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of this stock is insignificant. Despite abundance fluctuations in these stocks over time, this population is currently considered healthy and the proposed alternatives would not result in significant changes to the baseline condition.

Changes in habitat

- ***Direct and indirect effects of the proposed action.*** The crab fishery for Aleutian Islands golden king may impact the habitat in the Aleutian Islands; however, given the low level of fishing effort compared to the total area, the effects are expected to be insignificant. Since the alternative rationalization programs would not change harvest levels or current closures from the status quo conditions, this conclusion applies to all proposed alternatives. Effects of pot gear on living and non-living substrate are discussed in Section 4.9.3.

- ***Past actions with persistent effects.*** Setting and retrieval of longline pot gear amidst the steep bottom topography found throughout the Aleutian Islands could have damaged habitat but the significance of this effect to benthic communities has not been determined. Bottom trawling associated with past foreign, JV, and domestic fisheries has directly impacted benthic habitat and other marine substrates used by golden king crab in certain areas of the Aleutian Islands. However, impacts to golden king crab habitat by groundfish fisheries are presumed minimal due to the rough bottom terrain which is not conducive to trawling. Adverse past effects on crab habitat from these fisheries may still persist.

- ***Reasonably foreseeable future external actions.*** Impacts to crab habitat by groundfish fisheries could occur but the significance of these effects to crab populations has not been determined. In addition, contamination of essential habitat could cause population-level effects on crab. However, climatic variability is not expected to result in changes to benthic habitat.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of this stock is considered insignificant due to the low level of fishing effort relative to the total habitat area. Distribution of this population extends into depths greater than those currently fished and it is not clear if habitat in shallow areas is impacted by current fishing practices or still experiencing impacts from past effects. The cumulative condition, resulting from past actions, internal fishery activities, and reasonably foreseeable future external actions, cannot be determined until a baseline condition has been established.

<u>Change in reproductive success</u>

- ***Direct and indirect effects of the proposed action.*** Effects of the BSAI crab fishery under status quo and the alternative rationalization programs on reproductive success of golden king crab are presently not known (Section 4.2.2). Overall, reproductive success within crab populations is an underlying factor in the fluctuating abundance of these stocks. However, significance of fisheries-related effects on reproductive success at the population-level is not known with certainty. However, the conservative harvest strategies are applied to the crab stocks to prevent the fisheries from significantly impacting the reproductive success of the stock. Therefore, the crab fisheries are presumed to have an insignificant effect on reproductive success.

- ***Past actions with persistent effects.*** Past fisheries may have indirectly impacted reproductive success of some crab populations by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of fishing activity. Effects from disruption of spawning aggregations by past directed fishing and trawl bycatch may still exist. Highgrading and removal of legal males via crab fisheries could alter the sex ratio within the population and have lingering effects on reproductive and recruitment success.

- ***Reasonably foreseeable future external actions.*** Bycatch of crab and damage to spawning or nursery habitat by groundfish trawl and pot fisheries could affect sustainability in crab populations. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance and annual recruitment has not been studied and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** Overall, the fluctuating abundance of crab stocks is directly related to their reproductive success. However, the nature of this relationship has not been defined and the effects that fisheries have on these fluctuations have not been characterized. In addition, disruption of spawning aggregations by fishing activity could lead to reduced recruitment. Thus, the incremental contribution of the proposed rationalization programs to the overall cumulative effect status for this stock is presumed to be insignificant because conservative harvest strategies prevent impacts to reproductive success.

Bering Sea and Aleutian Islands Tanner crab

Mortality

- ***Direct and indirect effects of the proposed action.*** Overall, none of the alternative rationalization programs would affect total removals of crab or harvest level-setting processes and are, therefore, considered insignificant to overall mortality within crab stocks. In addition, the Tanner crab fishery is currently closed until abundance increases. Thus, internal fishing effects on mortality are not considered a contributing factor in the current status of this stock.

- ***Past actions with persistent effects.*** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960's 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. Bycatch in Federal and State groundfish fisheries (trawl, pot, and hook and line), halibut fisheries, and scallop fisheries also have contributed to mortality within this stock. A directed fishery for Tanner crab began in 1974 in the Bering Sea. Stock declines led to a closure in 1986 and 1987 and again from 1997-present. Mature biomass in Bering Sea crab stocks are currently low, and NOAA Fisheries declared this fishery overfished in 1999. Thus, adverse past effects of mortality on Bering Sea Tanner crab stocks from directed crab catch and bycatch may still exist. Eastern Aleutian Islands stocks had a directed fishery in the 1960's but a fishery has not been permitted since 1994 due to low abundance. No population estimates are available for eastern Aleutian Islands stocks and past effects are unknown.

- ***Reasonably foreseeable future external actions.*** Alaska scallop fisheries have the potential for spatial overlap with crab populations and catch Bering Sea Tanner crabs as bycatch. However, impacts are considered negligible due to the small number of vessels currently participating in the scallop fishery. Bycatch of crab in Federal and State groundfish fisheries occurs and is expected to continue in the foreseeable future. In 2001 and 2002, bycatch of Tanner crab in the groundfish fisheries was 1.4 and 1.0 million crab, respectively. Trawl and pot fisheries for Pacific cod in State waters also introduce potential for crab bycatch. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance has not been studied and chronic effects associated with these pathways are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is considered insignificant. The fisheries remain closed and the proposed action would not result in significant changes to the baseline condition of the BSAI Tanner crab populations. Total mature biomass of Bering Sea Tanner crab stock is low with continued closure of the directed fishery. The eastern Aleutian Islands Tanner crab fishery has been closed since 1994 and declines in stock abundance have been shown. Both eastern and western Aleutian Islands Tanner fisheries remain closed due to declining stock size and poor fishery performance.

Changes in habitat

- ***Direct and indirect effects of the proposed action.*** Based on the relatively small areas that are impacted by pot gear in the Tanner crab fisheries, the BSAI Tanner crab fisheries (when they occur) are considered to have insignificant effects on benthic habitat. Cumulative effects of pot gear on living and non-living substrate are discussed in Section 4.9.3.

- ***Past actions with persistent effects.*** Setting and retrieval of pot gear could have damaged crab habitat but the significance of this effect to benthic communities has not been determined. Bottom trawling associated with past foreign, JV, and domestic groundfish fisheries has directly impacted benthic habitat and other marine substrates used by crab in certain areas of the BSAI. Adverse past effects on crab habitat from these fisheries could still persist.

- ***Reasonably foreseeable future external actions.*** Potential for significant spatial overlap between scallop fisheries and crab habitat in this region could occur but impacts are considered negligible due to the small number of vessels currently participating in the scallop fishery. Impacts to crab habitat by groundfish fisheries using trawl and pot gear are likely to continue to occur in the future but the significance of this effect to crab populations has not been determined. Trawl fisheries in State waters, and pot gear is used in the Pacific cod fisheries contribute to potential impacts on crab habitat. In addition, contamination of essential habitat could cause population-level effects on crab. Climatic variability is not expected to result in changes to physical habitat.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant. The fisheries remain closed and the proposed action would not result in changes to the current baseline condition. Persistent past effects have not been characterized to date and it is not clear if crab habitat in shallow areas is impacted by current fishing practices. Thus, the cumulative condition, resulting from past and future external actions, has not been determined.

Change in reproductive success

- ***Direct and indirect effects of the proposed action.*** Effects of the BSAI crab fisheries on reproductive success of Tanner crab, under status quo and the alternative rationalization programs, are presumed to be insignificant. The fisheries are closed and are not considered contributing factors to the overall status of these stocks (Section 4.2.2). Reproductive success within crab populations is an underlying factor in the fluctuating abundance of these stocks, but significance of fisheries-related effects on a population-level have not been determined. Conservative harvest strategies, and fishery closures at low levels of abundance, are applied to the crab stocks to prevent the fisheries from significantly impacting the reproductive success of the stock.

- ***Past actions with persistent effects.*** Past foreign, JV, and domestic fisheries may have indirectly impacted reproductive success of some crab populations by removing vital brood stocks and/or disrupting spawning and nursery habitat via bottom trawling. Effects from the disruption of spawning aggregations by past fishing activities may still persist.

- ***Reasonably foreseeable future external actions.*** Alaska scallop fisheries spatially overlap with Tanner crab populations and introduce bycatch potential in this region, but impacts are considered negligible due to the small number of vessels currently participating in the fishery. Bycatch of crab and damage by trawl gear to spawning or nursery habitat by groundfish trawl and pot fisheries could impact reproductive success within crab populations. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance and annual recruitment has not been studied and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant . Reproductive success influences stock abundance and the population status of Tanner crab in this region is depressed. Total mature biomass of Bering Sea Tanner crab stocks is low, and continued closure of the crab fishery occurs. Both eastern and western Aleutian Islands Tanner fisheries remain closed due to declining stock size and poor fishery performance. If these stocks recover and fishing resumes, alternative rationalization programs may promote better communication among vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered, thus minimizing bycatch and mortality of these crabs.

Bering Sea snow crab

<u>Mortality</u>

- ***Direct and indirect effects of the proposed action.*** Indicators of crab mortality in the crab fisheries are discussed in Section 4.2.2. Overall, none of the alternative rationalization programs would affect the total removal of crab, change current closures, or the harvest level-setting processes. Their potential effects on mortality are considered insignificant to Bering Sea snow crab populations.

- ***Past actions with persistent effects.*** Direct catch and bycatch of crab are associated with past foreign, JV, and domestic fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960's 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. Bycatch in Federal and State groundfish fisheries (trawl, pot, and hook and line), halibut fisheries, and scallop fisheries also have contributed to overall mortality within this stock. Bycatch of snow crab in the groundfish fisheries in 2000 and 2001 was 3,285,000 and 2,067,400 million individuals, respectively (Section 3.5.3). A directed fishery for Bering Sea snow crab has existed since 1981 and accompanied a reduced Tanner crab harvest. Prior to 1981, harvest of snow crab was incidental to harvest of Tanner crab. A peak harvest of snow crab in 1991 was followed by a decline in stocks through 1996. Fishing has continued since 1996 with varying harvest levels. Thus, lingering adverse past effects of mortality on crab stocks from directed crab catch and bycatch in other fisheries may exist.

- ***Reasonably foreseeable future external actions.*** Although Alaska scallop fisheries occur in this region and introduce bycatch potential for crabs, the potential population-level impacts are considered negligible due to the small number of boats participating in the fishery. Bycatch of crab in Federal and State groundfish fisheries is expected to continue in future years. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance has not been studied and chronic effects associated with these pathways are unknown. In addition, climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is considered insignificant because none of the alternatives would result in significant changes to the baseline condition of these stocks. Snow crab stocks in this region are currently considered overfished and a rebuilding plan is in effect. Rationalization programs promote longer pot soaking times along with better communication between vessels for redirection of fishing effort when large aggregations of females and sub-legal males are encountered, further reducing bycatch potential for these crabs.

Changes in habitat

- ***Direct and indirect effects of the proposed action.*** Based on the relatively small areas that are impacted by pot gear in the snow crab fisheries, with crab habitat extending both north and seaward of the fishery impact zone, potential effects on benthic habitat are considered insignificant. Further discussion regarding effects of pot gear on living and non-living substrate is presented in Section 4.9.3.

- ***Past actions with persistent effects.*** Setting and retrieval of pot gear in this region in the past could have damaged habitat but the significance of these effects to benthic communities has not been determined. Bottom trawling associated with past foreign, JV, and domestic fisheries has directly impacted benthic habitat and other marine substrates used by crab in certain areas of the BSAI. Thus, adverse past effects on crab habitat from these fisheries could still exist.

- ***Reasonably foreseeable future external actions.*** Potential for spatial overlap between scallop fisheries and crab habitat in this region could occur but is considered negligible due to the small number of vessels currently participating in the fishery. Impacts to crab habitat by groundfish fisheries could occur but the significance of this effect to crab populations has not been determined. Thus, potential impacts to crab habitat could occur. In addition, contamination of essential habitat could result in population-level impacts to crab. Climatic variability is not expected to result in changes to physical habitat.

- **Cumulative effect.** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of this stock is insignificant. Implementing any of the proposed alternatives would not result in significant changes to the baseline condition of snow crab populations in this region. Distribution of this population extends into depths greater than those fished.

Change in reproductive success

- ***Direct and indirect effects of the proposed action.*** Indicators of reproductive effects in the BSAI crab fisheries are discussed in Section 4.2.2. Overall, reproductive success within crab populations are an underlying factor in the fluctuating abundance of these stocks. However, the nature of this relationship has not been well defined and the effects that fisheries have on these fluctuations, by removing mature males from the populations or impacting sub-adult males and females through bycatch, have not been characterized with certainty. However, the conservative harvest strategies are applied to the crab stocks to prevent the fisheries from significantly impacting the reproductive success of the stock. Therefore, the crab fisheries are presumed to have an insignificant effect on reproductive success.

- ***Past actions with persistent effects.*** Past foreign, JV, and domestic fisheries may have impacted reproductive success of some crab populations by removing vital brood stocks and/or adversely impacting spawning and nursery habitat via bottom trawling. Adverse effects from disruption of spawning aggregations by past directed fishing and trawl bycatch may still exist. Within the crab fishery, highgrading and removal of legal males could alter the sex ratio within the population and have lingering effects on reproduction and recruitment success.

- ***Reasonably foreseeable future external actions.*** Potential effects from scallop fisheries are considered negligible due to the small number of vessels currently participating in the fishery. Bycatch of adult crab or damage to spawning or nursery habitat by groundfish trawl and pot fisheries could impact reproductive success within crab populations. An acute pollution event such as an oil spill could directly or indirectly impact crab populations via numerous exposure pathways. The role of environmental contamination and persistence of pollutants in changes to crab abundance and annual recruitment has not been studied and chronic effects are unknown. Climatic variability may exert either beneficial or adverse effects on crab depending on the direction of change.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization programs to the overall cumulative effect status of these stocks is insignificant because conservative harvest strategies prevent impacts to reproductive success. Reproductive success influences stock abundance and snow crab stocks in this region are currently considered overfished with a rebuilding plan in effect. However, the overall baseline condition is difficult to determine until a better understanding of the relationship between reproductive success and abundance is achieved.

Table 4.9-1 Cumulative effects analysis for Pribilof Islands red king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Mortality	**Insignificant**	Direct catch and bycatch in past foreign, JV, and domestic fisheries; climatic variability.	No contribution- fishery does not occur near this stock.	Negligible contribution- because of Pribilof Islands habitat conservation area, some crab bycatch and habitat disruption through bottom trawling outside this area.	No contribution- State groundfish fisheries do not occur near this stock	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on direction of change.	**Insignificant-** alternatives considered would not result in significant changes to the baseline condition. Cumulative condition: stock abundance is increasing but population fluctuations still occur.
Changes in habitat	**Insignificant**	Setting and retrieval of pot gear, bottom trawling, and dredging in past fisheries.	see above.	see above	See above	Potential adverse contribution- contamination of essential habitat.	Not a contributing factor- not expected to result in changes to physical habitat.	**Insignificant-** alternatives considered would not result in significant changes to the baseline condition. Cumulative condition: fishing impacts on habitat may exist but effects are unknown.

Table 4.9-1(Cont.) Cumulative effects analysis for Pribilof Islands red king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Change in reproductive success	**Unknown**	Disruption of spawning aggregations, highgrading, bycatch of female and sub-legal males in crab fisheries; bycatch and habitat disruption in past bottom trawl fisheries.	see above	see above	see above	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on direction of change.	**Insignificant -** conservative harvest strategies prevent effects of fisheries on reproductive success. Cumulative condition: stock abundance is increasing but population fluctuations still occur.

*** Includes legal male, sub-legal male, and female crab**

Table 4.9-2 Cumulative effects analysis for Aleutian Islands red king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Mortality	**Insignificant**	Direct catch and bycatch in past foreign, JV, and domestic fisheries; climatic variability.	Not a contributing factor- does not occur in this region.	Potential adverse contribution- crab bycatch and habitat disruption through bottom trawling.	Potential adverse contribution- bycatch of crab and disruption of habitat through trawl fisheries and pot gear used in the Pacific cod fisheries.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: stocks remain depressed and below historic abundance but signs of recovery have been shown in western Aleutian Islands stocks.
Changes in habitat	**Insignificant**	Setting and retrieval of pot gear and trawling in past fisheries.	Not a contributing factor- does not occur in this region.	Potential adverse contribution- habitat disruption through bottom trawling.	Potential adverse contribution- disruption of habitat through trawl fisheries and pot gear used in the Pacific cod fisheries.	Potential adverse contribution- contamination of essential habitat.	Not a contributing factor- not expected to result in changes to physical habitat.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: fishing impacts on habitat may exist but effects are unknown.

Table 4.9-2(Cont.) Cumulative effects analysis for Aleutian Islands red king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Change in reproductive success	**Insignificant**	Disruption of spawning aggregations, highgrading, bycatch of female and sub-legal males in crab fisheries; bycatch and habitat disruption in trawl fisheries.	Not a contributing factor- does not occur in this region.	Potential adverse contribution- bycatch of adult crab and/or damage to spawning or nursery habitat.	Potential adverse contribution- bycatch of adult crab or damage to spawning or nursery habitat.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on direction of change.	**Insignificant -** conservative harvest strategies prevent effects of fisheries on reproductive success Cumulative condition: stocks remain depressed and below historic abundance but signs of recovery have been shown in western Aleutian Islands stocks.

*** Includes legal male, sub-legal male, and female crab**

Table 4.9-3 Cumulative effects analysis for Bristol Bay red king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum pollution and environmental contamination	Long-term climate variability and regime shift	
Mortality	**Insignificant**	Direct catch and bycatch in past foreign, JV, and domestic fisheries; climatic variability.	Negligible Contribution- bycatch occurs but at relatively low levels.	Potential adverse contribution- crab bycatch and habitat disruption through bottom trawling.	Potential adverse contribution- bycatch of crab and disruption of habitat through trawl fisheries and pot gear used in the Pacific Cod fisheries.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: stocks still exhibit fluctuations in abundance but are currently considered stable.
Changes in habitat	**Insignificant**	Setting and retrieval of pot gear, bottom trawling, and dredging.	Negligible Contribution- small number of vessels participating in fishery.	Potential adverse contribution- habitat disruption through bottom trawling.	Potential adverse contribution- disruption of habitat through trawl fisheries and pot gear used in the Pacific cod fisheries.	Potential adverse contribution- contamination of essential habitat.	Not a contributing factor- not expected to result in changes to physical habitat.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: fishing impacts on habitat may exist but effects are unknown.
Change in reproductive success	**Insignificant**	Disruption of spawning aggregations, highgrading, bycatch of female and sub-legal males in crab fisheries.	Negligible Contribution- bycatch occurs but at relatively low levels; minimal impacts to spawning or nursery habitat.	Potential adverse contribution- bycatch of adult crab and/or damage to spawning or nursery habitat.	Potential adverse contribution- bycatch of adult crab or damage to spawning or nursery habitat.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant -** conservative harvest strategies prevent effects of fisheries on reproductive success Cumulative condition: stocks still exhibit fluctuations in abundance but are currently considered stable.

*** Includes legal male, sub-legal male, and female crab**

Table 4.9-4 Cumulative effects analysis for Bering Sea (St. Matthews and Pribilof Islands) blue king crab*- Status Quo and Alternative Rationalization Management Plan

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum pollution and environmental contamination	Long-term climate variability and regime shift	
Mortality	**Insignificant**	Direct catch and bycatch in past foreign, JV, and domestic fisheries; climatic variability.	Not a contributing factor- does not occur in this region.	Not a contributing factor- State and federal waters are closed to trawling in this region.	Negligible Adverse Contribution- bycatch in Pacific cod pot fisheries; State and federal waters are closed to trawling in this region.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential Adverse or Beneficial Contribution- potential effects depend on the direction of change.	**Insignificant-** alternatives considered would not result in significant changes to the baseline condition. Cumulative condition: stocks are considered overfished and recovery has not been shown to date.
Changes in habitat	**Insignificant**	Setting and retrieval of pot gear, bottom trawling, and dredging in past fisheries.	Not a contributing factor- does not occur in this region.	Not a contributing factor- State and federal waters are closed to trawling in this region.	Potential adverse contribution- setting and retrieval of gear in Pacific cod pot fisheries; State and federal waters are closed to trawling in this region.	Potential adverse contribution- contamination of essential habitat.	Not a contributing factor- not expected to result in changes to physical habitat.	**Insignificant-** alternatives considered would not result in significant changes to the baseline condition. Cumulative condition: fishing impacts on habitat may exist but effects are unknown.

Table 4.9-4 (Cont.) Cumulative effects analysis for Bering Sea (St. Matthews and Pribilof Islands) blue king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum pollution and environmental contamination	Long-term climate variability and regime shift	
Change in reproductive success	**Insignificant**	Disruption of spawning aggregations, highgrading, bycatch of female and sub-legal males in crab fisheries; habitat disruption in past bottom trawl fisheries.	Not a contributing factor- does not occur in this region.	Not a contributing factor- State and federal waters are closed to trawling in this region.	Potential adverse contribution- bycatch and damage to spawning or nursery habitat in Pacific cod pot fisheries; State and federal waters are closed to trawling in this region.	Potential adverse contribution- acute and/or chronic pollution affecting reproductive success in crab populations.	Potential adverse or beneficial contribution- potential effects depend on the direction of change.	**Insignificant-** conservative harvest strategies prevent effects of fisheries on reproductive success. Cumulative condition: stocks are considered overfished and recovery has not been shown to date.

*** Includes legal male, sub-legal male, and female crab**

Table 4.9-5 Cumulative effects analysis for Bering Sea golden king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Mortality	**Insignificant**	Directed fishery in Pribilof district since 1982. Peak harvest in 1999. St Matthew Island fishery began in 1982 but no harvest since 1996.	Not a contributing factor- no bycatch of golden king reported.	Potential adverse contribution- crab bycatch and habitat disruption through bottom trawling.	Potential adverse contribution- bycatch of crab and disruption of habitat through trawl fisheries and pot gear used in the Pacific Cod fisheries.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential Adverse or Beneficial Contribution- effects depend on the direction of change.	**Insignificant-** alternatives considered would not result in significant changes to the baseline condition. Cumulative condition: no abundance estimates exist for these stocks and population status is currently unknown.
Changes in habitat	**Insignificant**	Disruption of benthic habitat through setting and retrieval of pot gear, bottom trawling, and dredging.	Negligible contribution- currently a small number of vessels participating in fishery.	Negligible contribution- rough bottom terrain is not conducive to trawling.	Negligible contribution- rough bottom terrain is not conducive to trawling; disruption of habitat by pot gear used in the Pacific cod fisheries.	Potential adverse contribution- contamination of essential habitat.	Not a contributing factor- not expected to result in changes to physical habitat.	**Insignificant-** alternatives considered would not result in significant changes to the baseline condition. Cumulative condition: fishing impacts on habitat may exist but effects are unknown.
Change in reproductive success	**Insignificant**	Disruption of spawning aggregations, highgrading, bycatch of female and sub-legal males in past crab fisheries; bycatch and habitat disruption in past bottom trawl fisheries.	Not a contributing factor- no bycatch of golden king reported.	Potential adverse contribution- bycatch of adult crab and/or damage to spawning or nursery habitat.	Potential adverse contribution- bycatch of adult crab or damage to spawning or nursery habitat.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant-** conservative harvest strategies prevent effects of fisheries on reproductive success. Cumulative condition: no abundance estimates exist for these stocks and population status is currently unknown.

*** Includes legal male, sub-legal male, and female crab**

Table 4.9-6 Cumulative effects analysis for Aleutian Islands golden king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum pollution and environmental contamination	Long-term climate variability and regime shift	
Mortality	**Insignificant**	Direct catch and bycatch in past foreign, JV, and domestic fisheries; climatic variability.	Not a contributing factor- does not occur in this region.	Potential adverse contribution- bycatch of crab and habitat disruption through bottom trawling.	Potential adverse contribution- bycatch of crab and disruption of habitat through trawl fisheries and pot gear used in the Pacific cod fisheries.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: despite abundance fluctuations in these stocks over time, this population is considered healthy.
Changes in habitat	**Insignificant**	Setting and retrieval of pot gear, bottom trawling, and dredging in past fisheries.	Not a contributing factor- does not occur in this region.	Potential adverse contribution- habitat disruption through bottom trawling.	Potential adverse contribution- disruption of habitat through trawl fisheries and pot gear used in the Pacific cod fisheries.	Potential adverse contribution- contamination of essential habitat.	Not a contributing factor- not expected to result in changes to physical habitat.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: fishing impacts on habitat may exist but effects are unknown.

Table 4.9-6(Cont.) Cumulative effects analysis for Aleutian Islands golden king crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum pollution and environmental contamination	Long-term climate variability and regime shift	
Change in reproductive success	**Insignificant**	Disruption of spawning aggregations, highgrading, bycatch of female and sub-legal males in crab fisheries; bycatch and habitat disruption in bottom trawl fisheries.	Not a contributing factor- does not occur in this region.	Potential Adverse Contribution- bycatch of adult crab and/or damage to spawning or nursery habitat.	Potential adverse contribution- incidental bycatch of adult crab or damage to spawning or nursery habitat.	Potential adverse contribution- Acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant** conservative harvest strategies prevent effects of fisheries on reproductive success cumulative condition- despite abundance fluctuations in these stocks over time, this population is considered healthy.

*** Includes legal male, sub-legal male, and female crab**

Table 4.9-7 Cumulative effects analysis for BSAI Tanner crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Mortality	**Insignificant**	Direct catch and bycatch in past foreign, JV, and domestic fisheries; climatic variability.	Negligible contribution- bycatch occurs but at relatively low levels.	Potential adverse contribution- crab bycatch and habitat disruption through bottom trawling.	Potential adverse contribution- bycatch of crab and disruption of habitat through trawl fisheries and pot gear used in the Pacific Cod fisheries.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential Adverse or Beneficial Contribution- effects depend on the direction of change.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: total mature biomass of Bering Sea stocks is below minimum stock threshold; continued closure of fishery occurs; Both eastern and western Aleutian Islands fisheries remain closed due to declining stock size and poor fishery performance.
Changes in habitat	**Insignificant**	Disruption of benthic habitat through setting and retrieval of pot gear, bottom trawling, and dredging.	Negligible contribution- minimal impact due to small number of vessels participating in fishery.	Potential adverse contribution- habitat disruption through bottom trawling.	Potential adverse contribution- disruption of habitat through trawl fisheries and pot gear used in the Pacific cod fisheries.	Potential adverse contribution- contamination of essential habitat.	Not a contributing factor- climatic variation and regime shift is not expected to result in changes to physical habitat.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: fishing impacts on habitat may exist but effects are unknown.

Table 4.9-7(Cont.) Cumulative effects analysis for BSAI Tanner crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Change in reproductive success	**Insignificant**	Disruption of spawning aggregations, highgrading, bycatch of female and sub-legal males in crab fisheries; bycatch and habitat disruption in trawl fisheries.	Negligible contribution- bycatch occurs but at relatively low levels; minimal impacts to spawning or nursery habitat.	Potential adverse contribution- bycatch of adult crab and/or damage to spawning or nursery habitat.	Potential adverse contribution- bycatch of adult crab or damage to spawning or nursery habitat.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant** - conservative harvest strategies prevent effects of fisheries on reproductive success. Cumulative condition: total mature biomass of Bering Sea stocks is below minimum stock threshold; Continued closure of fishery occurs; both eastern and western Aleutian Islands fisheries remain closed due to declining stock size and poor fishery performance.

*** Includes legal male, sub-legal male, and female crab**

Table 4.9-8 Cumulative effects analysis for Bering Sea snow crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Mortality	**Insignificant**	Direct catch and bycatch in past foreign, JV, and domestic fisheries; climatic variability.	Negligible contribution- currently a small number of vessels participating in fishery.	Potential adverse contribution- crab bycatch and habitat disruption through bottom trawling.	Potential adverse contribution- bycatch of crab and disruption of habitat through trawl fisheries and pot gear used in the Pacific cod fisheries.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant-** alternatives considered would not result in significant changes to the baseline condition. Cumulative condition: stocks are not stable and total mature biomass is below minimum stock threshold; Stock is considered overfished and rebuilding plan is in place.
Changes in habitat	**Insignificant**	Setting and retrieval of pot gear, bottom trawling, and dredging in past fisheries.	Negligible contribution- currently a small number of vessels participating in fishery.	Potential adverse contribution- habitat disruption through bottom trawling.	Potential adverse contribution- disruption of habitat through trawl fisheries and pot gear used in the Pacific cod fisheries.	Potential adverse contribution- contamination of essential habitat.	Not a contributing factor- not expected to result in changes to physical habitat.	**Insignificant-** alternatives considered would not result in significant changes to the baseline condition. Cumulative condition: fishing impacts on habitat may exist but effects are unknown.

Table 4.9-8 (Cont.) Cumulative effects analysis for Bering Sea snow crab*- Status Quo and Alternative Rationalization Management Plans

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Scallop fisheries	Alaska groundfish fisheries (NOAA fisheries)	State groundfish fisheries	Petroleum Pollution and environmental contamination	Long-term climate variability and regime shift	
Change in reproductive success	**Insignificant**	Disruption of spawning aggregations, highgrading, bycatch of female and sub-legal males in crab fisheries; bycatch and habitat disruption via bottom trawl fisheries.	Negligible contribution- currently a small number of vessels participating in fishery.	Potential adverse contribution- bycatch of adult crab and/or damage to spawning or nursery habitat.	Potential adverse contribution- bycatch of adult crab or damage to spawning or nursery habitat.	Potential adverse contribution- acute and/or chronic pollution; contamination of essential habitat.	Potential adverse or beneficial contribution- effects depend on the direction of change.	**Insignificant-** conservative harvest strategies prevent effects of fisheries on reproductive success. Cumulative condition: stocks are not stable and total mature biomass is below minimum stock threshold; Stock is considered overfished and rebuilding plan is in place.

*** Includes legal male, sub-legal male, and female crab**

4.9.3 Cumulative effects analysis for ESA-listed seabirds

4.9.3.1 Short-tailed albatross

The past/present effects on short-tailed albatross are described in the Alaska Groundfish Fisheries Draft Programmatic Supplemental EIS (NMFS 2003b) and summarized below. The predicted direct and indirect effects of the BSAI king and Tanner crab fisheries under the alternative rationalization programs are described in Section 4.3.4. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. Acknowledging the fact that some events will tend to offset or mitigate other effects, this cumulative effects analysis seeks to provide an overall assessment of the species' population level response to its environment as it is influenced by the crab fisheries. The effects considered in this analysis are listed in Table 4.9-9. In the interest of clarity and brevity, only the most important factors will be discussed as they pertain to the cumulative effects conclusion.

<u>Incidental Take/Mortality</u>

- ***Direct and indirect effects of the proposed action.*** Under all alternative rationalization programs, the chances of taking short-tailed albatross incidentally in the crab fisheries are considered extremely unlikely and are thus considered insignificant at the population level.

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

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

- ***Cumulative effect.*** The cumulative effect on short-tailed albatross is considered to be insignificant. The cumulative condition is that the population appears to be increasing at a near maximum rate. However, this situation could change if natural or human-caused mortality rates increase by small amounts or if a catastrophe occurs on or near Torishima Island. The risk of mortality from crab fisheries is considered extremely unlikely and not expected to have population level effects.

Prey availability

- ***Direct and indirect effects of proposed action.*** Under all alternative rationalization programs, the crab fisheries would have negligible, if any, effect on squid and forage fish through bycatch. This effect is considered insignificant at the population level for short-tailed albatross.

- ***Past actions with persistent 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.

- ***Reasonably foreseeable future external actions.*** Squid and forage fish fisheries could have adverse effects on short-tailed albatross prey availability, however, the collapse of the short-tailed albatross population was due to direct harvest rather than loss or change of habitat. The growth rate of the population should not be limited in the foreseeable future by the carrying capacity of the environment, which once supported millions of birds. Conservation efforts such as the National and International Seabird Bycatch Reduction Plans, focusing on repairing and protecting nest sites, and the reintroduction of individuals to previous nesting sites are considered beneficial effects. 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 effect.*** The cumulative effect of prey availability is insignificant. The cumulative condition is that bycatch of prey in the crab fisheries is very small and would not have population level effects as this species does not appear to be food limited.

Benthic habitat

- ***Direct and indirect effects of the proposed action.*** Under all alternative rationalization programs, the crab fisheries would have negligible, if any, effect on squid and forage fish populations through potential benthic habitat effects. This effect is considered insignificant at the population level for short-tailed albatross.

- ***Past actions with persistent effects.*** 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 fishing gear or any other disturbance would have no discernable effect on their prey. Their overall prey abundance is determined mostly by natural fluctuations in primary productivity and oceanographic factors.

- ***Reasonably foreseeable future external actions.*** There are no foreseeable actions that will likely have more than a negligible effect on short-tailed albatross prey availability through potential changes in benthic habitat.

- ***Cumulative effect.*** The cumulative effect is considered insignificant. The cumulative condition is that changes on benthic habitat from fishing gear or other disturbance would not affect albatross prey that occur in the upper and middle levels of the water column. There is no known mechanism for effects on albatross prey availability.

Oil pollution

- ***Direct and indirect effects of the proposed action.*** Under all alternative rationalization programs, the crab fisheries would contribute an unknown amount of oil pollution as a result of accidental releases and bilge cleaning. Since there is presently no way to track the effects of oil pollution from the individual fisheries, this effect is considered unknown.

- ***Past actions with persistent effects.*** Pollution from a variety of land and marine sources have potentially affected short-tailed albatross and their prey in the past but specific toxicological effects are unknown.

- ***Reasonably foreseeable future external actions.*** Given the large variety of marine and terrestrial sources of oil pollution, future chronic and acute effects on albatross seem likely but are unpredictable.

- ***Cumulative effect.*** The cumulative effect of human activities on the population of short-tailed albatross through oil pollution is considered to be unknown as the combined risk from particular sources is unpredictable. The cumulative condition is that oil pollution, either acute and/or chronic, could alter reproductive success and survival.

4.9.3.2 Spectacled eiders

The past/present effects on spectacled eiders are described in the Alaska Groundfish Fisheries Draft Programmatic Supplemental EIS (NMFS 2003b) and summarized below. The predicted direct/indirect effects of the BSAI king and Tanner crab fisheries under the alternative rationalization programs are described in Section 4.3.4. This section will assess the potential for these effects to interact with other reasonably foreseeable future actions in a cumulative way. Acknowledging the fact that some actions may offset or mitigate others, this cumulative effects analysis seeks to provide an overall assessment of the species' population level response to its environment, as influenced by the crab fisheries. The effects considered in this analysis are listed in Table 4.9-10.

Incidental take/mortality

- ***Direct and indirect effects of the proposed action.*** Spectacled eiders rarely interact directly with the status quo BSAI crab fisheries, no removals have been recorded either in pot gear or through vessel strikes. Although the alternative rationalization programs would likely extend the duration of the crab fishing season and therefore increase the chances of eider/fishery interactions relative to the status quo race-for-fish, incidental take of spectacled eiders is expected to remain a rare occurrence under all alternative rationalization programs and is considered insignificant at the population level.

- ***Past actions with persistent effects.*** Worldwide population estimates for spectacled eider exceed 300,000 birds but their Alaska-nesting populations have declined 95 percent in the last 30 years and they are now listed as threatened under the ESA. Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution, and lead shot poisoning on the nesting grounds.

- ***Reasonably foreseeable future external actions.*** 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, particularly in winter when birds are in massive concentrations.

- ***Cumulative effect.*** The cumulative effect is insignificant at the population level since the population may have stabilized and known human-caused mortality is very low . Under the cumulative condition the BSAI crab fisheries appear to contribute only rarely, if at all, to direct mortality of spectacled eiders. Direct sources of mortality do not appear to account for the past population decline in Alaska but toxic contamination from lead shot (the use of which is now illegal) could have played an important role.

<u>Prey availability</u>

- ***Direct and indirect effects of the proposed action.*** There is very little overlap between eider foraging areas, which are concentrated in waters less than 70 m deep, and deeper waters used by the crab fisheries. Under all alternative rationalization programs, the crab fisheries would have insignificant effects on eider prey through bycatch.

- ***Past actions with persistent effects.*** Spectacled eiders primarily prey on small marine invertebrates such as bivalves, snails, crustaceans, and polychaete worms. While several different fisheries may have caused some localized depletions of prey due to habitat effects (discussed below), the amount of these species taken as bycatch is generally thought to be very small relative to their natural abundance. Japanese and U.S. directed snail fisheries may also have caused localized depletions of prey, although the importance of these depletions to spectacled eider foraging success is unknown.

- ***Reasonably foreseeable future external actions.*** All future trawl and pot fisheries in waters important for eider foraging will potentially affect eider prey through bycatch or crushing. Pollution may also affect eider prey species, at least in shallow waters. Long-term climate change or regime shift may also have adverse or beneficial influences on prey abundance.

- ***Cumulative effect.*** The cumulative effect on prey availability is therefore considered to be insignificant at the population level. The cumulative condition of human-caused events on the abundance and distribution of spectacled eider prey species, including a small contribution from the crab fisheries, is considered to be minimal compared to natural fluctuations.

<u>Benthic habitat</u>

- ***Direct and indirect effects of the proposed action.*** Crab pots weigh up to 700 pounds and can disrupt benthic habitats that support the prey of eiders. Under the status quo crab fisheries, there is very limited spatial overlap with spectacled eider Critical Habitat (Norton Sound and St. Matthew Island area). Although the alternative rationalization programs would provide fishermen more time to explore new fishing grounds, it is predicted that they will choose to fish in areas that have been fished heavily in the past. The fishery is therefore expected to continue to have limited overlap with spectacled eider Critical Habitat. The overall effects of all alternative rationalization programs on eiders through potential changes in benthic habitat are considered insignificant at the population level.

- ***Past actions with persistent effects.*** Benthic habitats important to spectacled eiders have been affected by various trawl and pot fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated so it is unclear what or where habitat effects are persistent, especially with regard to the indirect effects on critical prey species. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may also have persistent effects in certain areas.

- ***Reasonably foreseeable future external actions.*** All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to potential adversely effect benthic habitat to some extent. Natural sources of benthic habitat disruption will also likely continue. Potential beneficial effects include nearshore trawl and bottom contact fishing closures.

- ***Cumulative effect.*** The cumulative effects of benthic habitat disruptions from natural and human events as they relate to the food web important to eiders are considered to be unknown. Under the cumulative condition, the BSAI crab fisheries are predicted to have little spatial overlap with spectacled eider habitat under all alternative rationalization programs. The interaction of human-caused and natural disturbances of benthic habitat important to eiders has not been examined with respect to their population declines in the past.

<u>Oil pollution</u>

- ***Direct and indirect effects of the proposed action.*** Under all alternative rationalization programs, the crab fisheries would contribute an unknown amount of oil pollution as a result of accidental releases and bilge cleaning. Since there is presently no way to track the effects of oil pollution from the fishery, this effect is considered unknown.

- ***Past actions with persistent effects.*** Pollution from a variety of land and marine sources have potentially affected spectacled eiders and their prey in the past but specific toxicological effects are unknown.

- ***Reasonably foreseeable future external actions.*** Given the large variety of marine and terrestrial sources of oil pollution, future chronic and acute effects on spectacled eider seem likely but are unpredictable.

- ***Cumulative effect.*** The cumulative effect of human activities on the population of spectacled eiders through oil pollution is considered to be unknown as the combined risk from particular sources is unpredictable. The cumulative condition is that oil pollution, either acute and/or chronic, could alter reproductive success and survival.

4.9.3.3 Steller's eiders

The past/present effects on Steller's eiders are described in the Alaska Groundfish Fisheries Final Programmatic Supplemental EIS (NMFS 2004a) and summarized below. The predicted direct/indirect effects of the BSAI king and Tanner crab fisheries under the alternative rationalization programs are described above in Section 4.3.4. This section will assess the potential for these effects to interact with other reasonably foreseeable future actions in a cumulative way. Acknowledging the fact that some events may offset or mitigate others, this cumulative effects analysis seeks to provide an overall assessment of the species' population level response to its environment, as influenced by the crab fisheries. The effects considered in this analysis are listed in Table 4.9-10.

<u>Incidental take/mortality</u>

- ***Direct and indirect effects of the proposed action.*** Steller's eiders interact with the crab fisheries to a limited extent but incidental take has been very rare. Incidental take of eiders is therefore considered to be insignificant at the population level under all alternative rationalization programs.

- ***Past actions with persistent effects.*** Past sources of mortality that may continue to have an effect on Steller's eiders include subsistence harvest, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution, and lead shot poisoning on the nesting grounds. Incidental take in the BSAI/GOA groundfish fisheries appears to have been very rare for Steller's eiders. Steller's eiders have been afforded protection through the ESA.

- ***Reasonably foreseeable future external actions.*** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Potential adverse contributions to declines may result from subsistence harvest in Northwestern Alaska and Russia. Incidental take in trawl/net gear and vessel strikes in the coastal fisheries could also result in adverse effects. Conservation concerns focus on preventing potential impacts in Critical Habitat areas.

- ***Cumulative effect.*** The cumulative effect is considered to be insignificant at the population level. The cumulative condition is that direct human-caused mortality of Steller's eider does not appear to account for the past population decline in Alaska.

Prey availability

- ***Direct and indirect effects of the proposed action.*** There is very little overlap between eider foraging areas, which are concentrated in waters less than 50 m deep, and deeper waters used by the crab fisheries. Under all alternative rationalization programs, the crab fisheries would have insignificant effects on eider prey through bycatch.

- ***Past actions with persistent effects.*** Steller's eiders primarily prey on small marine invertebrates such as bivalves, snails, crustaceans, and polychaete worms. While several different fisheries may have caused some localized depletions of prey due to habitat effects (discussed below), the amount of these species taken as bycatch is generally thought to be very small relative to their natural abundance. Japanese and U.S. directed snail fisheries may also have caused localized depletions of prey although the importance of these depletions to spectacled eider foraging success is unknown.

- ***Reasonably foreseeable future external actions.*** All future trawl and pot fisheries in waters important for eider foraging will potentially affect eider prey through bycatch or crushing. Pollution may also affect eider prey species, at least in intertidal areas. Long-term climate change or regime shift may also have adverse or beneficial influences on prey abundance depending on the direction of change.

- ***Cumulative effect.*** The cumulative effect on prey availability is considered to be insignificant at the population level. The cumulative condition of human-caused events on the abundance and distribution of Steller's eider prey species, including a small contribution from the crab fisheries, is considered to be minimal compared to natural fluctuations.

Benthic habitat

- ***Direct and indirect effects of the proposed action.*** Crab pots weigh up to 700 pounds and can disrupt benthic habitats that support the prey of eiders. Under the status quo crab fisheries, there is very limited spatial overlap with Steller's eider Critical Habitat (Nelson Lagoon). Although the alternative rationalization programs would provide fishermen more time to explore new fishing grounds, it is predicted that they will choose to fish in areas that have been fished heavily in the past. The fishery is therefore expected to continue to have limited overlap with Steller's eider Critical Habitat. The overall effects of all alternative rationalization programs on eiders through potential changes in benthic habitat are considered insignificant at the population level.

- ***Past actions with persistent effects.*** Benthic habitats important to 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 these effects by different types of fisheries have only begun to be investigated so it is unclear what or where habitat effects are persistent, especially with regard to the indirect effects on prey species important to eiders. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may also have persistent effects in certain areas.

- ***Reasonably foreseeable future external actions.*** All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to result in adverse effects to benthic habitat. Natural sources of benthic habitat disruption will also likely continue. Potential beneficial effects include nearshore trawl and bottom contact fishing closures.

- ***Cumulative effect.*** The cumulative effects of benthic habitat disruptions from natural and human events as they relate to the food web important to eiders, are unknown. Under the cumulative condition, the BSAI crab fisheries are predicted to have little spatial overlap with Steller's eider habitat under all alternative rationalization programs. The interaction of human-caused and natural disturbances of benthic habitat important to eiders has not been examined with respect to their population declines in the past.

Oil pollution

- ***Direct and indirect effects of the proposed action.*** Under all alternative rationalization programs, the crab fisheries would contribute an unknown amount of oil pollution as a result of accidental releases and bilge cleaning. Since there is presently no way to track the effects of oil pollution from the fishery, this effect is considered unknown.

- ***Past actions with persistent effects.*** Pollution from a variety of land and marine sources have potentially affected Steller's eider and their prey in the past but specific toxicological effects are unknown.

- ***Reasonably foreseeable future external actions.*** Given the large variety of marine and terrestrial sources of oil pollution, future chronic and acute effects on Steller's eider seem likely but are unpredictable.

- ***Cumulative effect.*** The cumulative effect of human activities on the population of Steller's eider's through oil pollution is unknown as the combined risk from particular sources is unpredictable. The cumulative condition is that oil pollution, either acute and/or chronic, could alter reproductive success and survival.

Table 4.9-9 Cumulative effects analysis for short-tailed albatross under all EIS alternatives

Table 4.9-9 Cumulative effects analysis for short-tailed albatross under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably Foreseeable Future External Effects				Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled		Natural		
			Other U.S., State, and Foreign Fisheries	Conservation efforts	Geologic disruption of nest sites	Long-term climate variability and regime shift	
Mortality - Incidental Take	**Insignificant**	Population recovering from near extinction caused by commercial hunting; most nesting on one Japanese volcanic island. Geologic instability of nest sites. Probable incidental take in Japan, foreign, and U.S. fisheries. Conservation efforts in Japan and U.S. fisheries.	Potential adverse contribution- incidental take on longlines, trawl/net gear, and vessel strikes.	Potential beneficial contributions- national and international seabird bycatch reduction plans. Japanese efforts to repair and protect nest sites. Reintroduction to previous nesting islands.	Potential adverse contribution- great majority of nesting occurs on Torishima Island, which is an active volcano.	Not a contributing factor.	**Insignificant**- proposed action would not result in significant changes to the baseline condition. Cumulative condition: species appears to be increasing at near maximum rate but situation could change substantially if natural or human mortality rates increase by small amounts or if catastrophe occurs on Torishima Island. Risk of mortality from crab fisheries is very small as incidental take would be a rare event and is considered a small part of the human-caused mortality.
Prey Availability	**Insignificant**	Squid and forage fish fisheries.	Potential adverse contribution- squid and forage fish fisheries.	Potential beneficial contribution- general efforts to reduce marine pollution.	Not a contributing factor.	Potential beneficial/ adverse contribution- influence of natural fluctuations on squid and forage fish abundance and distribution.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: species does not appear to be food-limited. Bycatch of prey in crab fisheries is very small.

Table 4.9-9 Cumulative effects analysis for short-tailed albatross under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably Foreseeable Future External Effects: Human-Controlled: Other U.S., State, and Foreign Fisheries	Human-Controlled: Conservation efforts	Natural: Geologic disruption of nest sites	Natural: Long-term climate variability and regime shift	Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
Benthic Habitat	**Insignificant**	None	Not a contributing factor.	Not a contributing factor.	Not a contributing factor.	Not a contributing factor.	**Insignificant**- proposed action would not result in significant changes to the baseline condition. Cumulative condition: no known mechanism of benthic effect on albatross prey availability. Changes in benthic habitat from fishing gear or other disturbance would not effect prey.
Oil Pollution	**Unknown**	Marine vessels and terrestrial sources.	Potential adverse contribution- Marine vessels and terrestrial sources.	Potential beneficial contribution- Oil spill prevention laws and regulations.	Not a contributing factor.	Not a contributing factor.	**Unknown**- combined risk from particular sources is unpredictable. Cumulative condition: acute and/or chronic pollution events could alter reproductive success and survival but the combined risk from many sources is unknown.

Table 4.9-10 Cumulative effects analysis for spectacled and Steller's eiders under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions: Human-Controlled: Subsistence hunting and egging	Human-Controlled: Other U.S., State, and foreign fisheries	Human-Controlled: Conservation efforts	Natural: Disturbance by ice, whales, and walrus	Natural: Long-term climate variability and regime shift	Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
Mortality - Incidental Take	**Insignificant**	Reason(s) for population declines of both species in Alaska unknown. Both species listed as threatened under ESA with designated Critical Habitat in project area. Subsistence hunts and egging. Incidental take in coastal fisheries. Lead shot pollution.	Potential adverse contribution- harvest in northwestern Alaska and Russia.	Potential adverse contribution- incidental take trawl/net gear and vessel strikes in coastal fisheries.	Potential beneficial contribution- oil spill and pollution prevention laws.	Not a contributing factor.	Not a contributing factor.	**Insignificant**- proposed action would not result in significant changes to the baseline. Cumulative condition: population declines may have stabilized, subsistence hunts dominate human-caused mortality but do not appear large enough to cause population declines.
Prey Availability	**Insignificant**	Regime shifts. Japanese directed snail fishery.	Not a contributing factor.	Potential adverse contribution- bycatch in trawls and pot fisheries.	Not a contributing factor.	Potential adverse contribution- disturbance may cause local prey depletions.	Potential adverse or beneficial contribution- influence of natural fluctuations on prey abundance.	**Insignificant-** proposed action would not result in significant changes to the baseline. Cumulative condition: bycatch and harvest of eider prey in all fisheries is very small and considered minimal compared to natural fluctuations.

Table 4.9-10(Cont.) Cumulative effects analysis for spectacled and Steller's eiders under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled			Natural		
			Subsistence hunting and egging	Other U.S., State, and foreign fisheries	Conservation efforts	Disturbance by ice, whales, and walrus	Long-term climate variability and regime shift	
Benthic Habitat	**Insignificant**	Disturbance of benthic habitat by gray whales and walrus. Trawling and other bottom contact fishing in critical habitat.	Not a contributing factor.	Potential adverse contribution- trawling and other bottom contact fishing in Critical Habitat.	Potential beneficial contribution- nearshore trawl and bottom contact fishing closures.	Potential adverse contribution- disturbance of bottom may cause changes in productivity and complexity of benthic habitat.	Potential adverse or beneficial contribution - effects depend on direction of change.	**Unknown -** contributions of natural events and human disturbance to food web dynamics of benthic habitat are unknown. Cumulative condition: there is little spatial overlap with eider habitat and disturbance to benthic habitat important to eiders. This has not been studied with respect to population declines.
Oil Pollution	**Unknown**	Marine vessels and terrestrial sources.	Potential adverse contribution- marine vessels used for hunting.	Potential adverse contribution- marine vessels and terrestrial sources.	Potential beneficial contribution- oil spill and pollution prevention laws.	Not a contributing factor.	Not a contributing factor.	**Unknown**- combined risk from particular sources is unpredictable. Cumulative condition: acute and/or chronic pollution events could alter reproductive success and survival but combined risk from many sources is unknown.

4.9.4 Cumulative effects analysis for marine mammals

4.9.4.1 Steller sea lions

The past/present effects on the western stock of Steller sea lions are described in the Alaska Groundfish Fisheries Draft Programmatic Supplemental EIS (NMFS 2003b) and summarized below. The predicted direct/indirect effects of the BSAI king and Tanner crab fisheries under the alternative rationalization programs are described in Section 4.3.4 of this document. This section will assess the potential for these effects to interact with other reasonably foreseeable future actions in a cumulative way. Acknowledging the fact that some actions will tend to offset or mitigate others, this cumulative effects analysis seeks to provide an overall assessment of the species' population-level response to its environment, as influenced by the crab fisheries. The effects considered in this analysis are listed in Table 4.9-11. In the interest of clarity and brevity, only the most important factors will be discussed as they pertain to the cumulative effects conclusion.

Incidental take/mortality

- ***Direct and indirect effects of the proposed action.*** Under all alternative rationalization programs, incidental take of Steller sea lions through entanglement in active or lost crab gear is expected to be rare and is therefore considered insignificant at the population level.

- ***Past actions with persistent effects.*** Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a 9 year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick et al 1987). Over 20,000 Steller sea lions are 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. In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 sea lions per year in the early 1990's to an average of 7.8 sea lions per year from 1996-2000. A small number of Steller sea lions are also incidentally taken in State-managed nearshore salmon gillnet fisheries and halibut longline fisheries. Intentional shooting of sea lions by fishermen used to be a significant source of mortality prior to their listing as "endangered " under the ESA. Subsistence harvest of western stock Steller sea lions has decreased over the last ten years from 547 to 171 animals per year (1992-1998) (Angliss and Lodge 2002).

- ***Reasonably Foreseeable Future Actions.*** Potential adverse contributions from incidental take in the State-managed salmon gillnet fisheries will continue in the foreseeable future but will likely remain relatively low (<10 per year). Potential adverse contributions that result from entanglement in fishing gear and intentional shootings would also be expected to continue at levels similar to the baseline condition. Subsistence harvest throughout the range of the western stock of Steller sea lions may contribute to a potential adverse effect. Marine pollution and vessel hazards may contribute to future mortality from the loss of fishing gear and other material from fishing and shipping vessels and shoreside processors although the intensity of this effect is unpredictable. Potential beneficial contributions may result from the ESA, MMPA, and Marine Plastics Pollution Research and Control Act (MPPRCA). Direct mortality would not be a primary effect resulting from climatic variability and regime shift.

- ***Cumulative effect.*** The cumulative effect of mortality is considered insignificant as the proposed action would not result in changes to the baseline condition. The incremental contribution of the crab fisheries to the cumulative condition is minimal as incidental take of Steller sea lions in the crab fisheries is a rare event and is considered a very small part of the human-caused mortality.

Competition for Food

- ***Direct and indirect effects of the proposed action.*** The harvest and bycatch of Steller sea lion prey species in the BSAI crab fisheries is expected to be negligible under all alternative rationalization programs and is therefore considered to be insignificant at the population level. NOAA Fisheries has determined that the crab fisheries do not result in adverse modification of Steller sea lion Critical Habitat.

- ***Past actions with persistent effects.*** Past effects on key prey species of Steller sea lions include harvest and bycatch by the BSAI/GOA groundfish fisheries and parallel fisheries in State waters, and partial overlap with other State-managed fisheries. These species were also targeted in past foreign and JV groundfish fisheries. NMFS Office of Protected Resources has issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat, with most of the focus on the western stock. The most recent BiOp and EIS (NMFS 2001b) explores this subject in great depth.

- ***Reasonably Foreseeable Future Actions.*** Federal and State-managed fisheries for groundfish, salmon, and herring are expected to continue in the future with an emphasis on avoiding jeopardy to Steller sea lions. New fisheries in State or federal waters are not anticipated. Climate change or regime shifts were identified as having potentially adverse or beneficial effects on availability of sea lion prey but the direction and magnitude of these changes are impossible to predict given our current ecological knowledge.

- ***Cumulative effect.*** The cumulative effect of the crab fisheries with regard to prey is considered insignificant. The cumulative condition for future population trends are conditional on prey being a limiting factor in population recovery. The contribution of the crab fisheries is limited. BSAI crab fisheries would contribute a minimal amount to the total removal of sea lion prey species under all alternative rationalization programs.

Disturbance

- ***Direct and indirect effects of the proposed action.*** Regulations implemented to protect Steller sea lions under the ESA (50 CFR 223.202) would continue under all alternative rationalization programs and include the prohibition of vessel entry within 3 nautical miles (nm) of listed rookeries. Measures have been implemented to avoid intentional and unintentional hazing of hauled out sea lions or those aggregated near shore. Crab fishing and processing vessels do not enter these sensitive areas. In addition, evidence is lacking for determination of population-level effects to Steller sea lions resulting from fishing related disturbances. Thus, potential effects of disturbance on Steller sea lions under the status quo and alternative rationalization programs are considered insignificant.

- ***Past actions with persistent effects.*** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI/GOA and State-managed fisheries. Past disturbances were also identified from commercial harvest, intentional shooting and subsistence harvest. Disturbance to Steller sea lion prey fields has also regularly occurred in the past from fishing gear and general vessel traffic.

- ***Reasonably Foreseeable Future Actions.*** Potential adverse effects resulting from future disturbance by fishing and non-fishing vessel traffic in Steller Sea lion foraging areas is anticipated. Subsistence harvest will also continue to disrupt sea lions in a few areas and may result in potential adverse conditions. However, the future level of disturbance is expected to be similar to baseline conditions. Disturbance from marine pollution hazards and vessels in the species range may also result in potential adverse effects.

- ***Cumulative effect.*** The cumulative disturbance to Steller sea lions, including a small contribution from the crab fleet, is considered insignificant. Under the cumulative condition, population-level effects are unlikely given the protection measures of the most sensitive areas implemented under the ESA. Disturbance elsewhere is likely temporary and not expected to affect the species at a population-level.

4.9.4.2 ESA-listed cetaceans

The past/present effects on ESA-listed cetaceans are described in the Alaska Groundfish Fisheries Draft Programmatic Supplemental EIS (NMFS 2003b) and summarized below. This group includes northern right whale, bowhead whale, blue whale, fin whale, sei whale, humpback whale, and sperm whale, all of which are listed as endangered. The predicted direct/indirect effects of the BSAI king and Tanner crab fisheries under the alternative rationalization programs are described in Section 4.3.4 of this document. This section will assess the potential for these effects to interact with other reasonably foreseeable future actions in a cumulative way. Acknowledging the fact that some actions will tend to offset or mitigate others, this cumulative effects analysis seeks to provide an overall assessment of the species' population-level response to its environment, as influenced by the crab fisheries. The effects considered in this analysis are listed in Table 4.9-12.

<u>Mortality</u>

- ***Direct and indirect effects of the proposed action.*** No removals of ESA-listed whales have been recorded in the BSAI crab fisheries, although some whales have been seen with evidence of entanglement in non-specified fishing gear (Angliss and Lodge 2002). Mortality from the crab fisheries is predicted to be insignificant at the population level for all ESA-listed cetaceans under all alternative rationalization programs.

- ***Past actions with persistent effects.*** Commercial whaling during the last century decimated the populations of all whales in this group and is the primary reason they are now listed as endangered. Subsistence whaling has also affected bowhead whales which are currently harvested under authority of the International Whaling Commission. Native hunters in Russia and Alaska are allowed 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. In 1997, a dead humpback whale 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 origin of the derelict gear. Two mortalities of humpbacks were reported by observers in the Bering Sea pollock trawl fishery operating near

Unimak Pass in October 1998 and February 1999. 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. 1993). Since 1992, additional bowhead whales have been observed entangled in pot gear or with scars from ropes. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. No incidental takes of right whales are known to have occurred in the north Pacific since that time. Sperm whales are known to prey on sablefish caught on commercial longline gear in the GOA and interactions with these fisheries may be increasing in frequency. Three sperm whale entanglements have been reported in the GOA longline fishery.

- ***Reasonably foreseeable future external actions.*** With the exception of commercial whaling, all sources of past mortality listed above are expected to continue. Potential adverse effects may result from incidental take in the State-managed drift and gill net fisheries. Entanglement in fishing gear is considered a potential adverse effect that may or may not lead to mortality but is likely to affect ESA-listed whales throughout their ranges. Potential adverse effects may result from subsistence hunts for bowhead whales which continue to be the largest source of human-caused mortality for that species. Additionally, potential adverse effects may result from the loss of gear and other material from fishing and shipping vessels as well as shoreside sources and vessel collisions. An acute or chronic pollution event, especially those involving oil, may result in adverse conditions for these species of whales. Direct mortality would not be a primary effect of climatic/regime change. Potential beneficial effects may result from the ESA, International Whaling Commission management of subsistence take, MMPA, and MPPRCA.

- ***Cumulative effect.*** The cumulative effects of mortality are considered insignificant. Under the cumulative condition, with the exception of bowhead whales, human-caused mortality of ESA-listed whales has been and is expected to remain a rare occurrence. Subsistence take of bowheads is closely regulated and the population appears to be increasing steadily. The contribution of the crab fisheries to mortality from entanglement is unknown however, the risk of mortality in crab fisheries is minimal as this fishery occurs primarily in the fall and winter months when most of the ESA-listed whales are not present in BSAI waters.

<u>Competition for food</u>

- ***Direct and indirect effects of the proposed action.*** The ESA-listed whales feed primarily on planktonic prey and a small amount of fish, except for sperm whales that prey on squid. The BSAI crab fisheries take negligible amounts, if any, of these prey species as bycatch. The crab fisheries are therefore considered to have an insignificant effect on whale prey abundance or distribution.

- ***Past actions with persistent effects.*** Past forage fish and squid fisheries may have caused local depletions of prey for ESA-listed whales. The overriding influence on prey availability is believed to be natural fluctuations in primary productivity and oceanic processes that concentrate prey.
- ***Reasonably foreseeable future external actions.*** Future actions with potentially adverse effects include harvest and bycatch of forage fish, squid, and other planktonic prey in both foreign and domestic fisheries throughout the range of these species. Fluctuations in climate and oceanographic factors may exert either a beneficial or adverse effects in determining prey abundance and distribution.

- ***Cumulative effect.*** The cumulative effect on food is considered insignificant at the population level for all ESA-listed whales. The cumulative condition is that the recoveries of these species do not appear to be food-limited and no human-caused factors are likely to substantially alter their food supplies. The crab fisheries are likely to have negligible effects on prey availability for ESA-listed whales as their harvest of prey is minimal and this fishery occurs primarily in the fall and winter months when most of the ESA-listed whales are not present in BSAI waters.

<u>Disturbance</u>

- ***Direct and indirect effects of the proposed action.*** The BSAI crab fisheries are prosecuted primarily in the fall and winter months when most of the ESA-listed whales are not present in BSAI waters. The alternative rationalization programs would tend to extend the fishery seasons but they would still be closed in the spring and summer months, when most whales are present, to protect molting crab. Disturbance of ESA-listed whales through crab vessel traffic and noise production is considered to be insignificant at the population-level for all species based on a lack of evidence for past adverse effects.

- ***Past actions with persistent effects.*** Some level of disturbance has likely occurred from all foreign, JV, and domestic fisheries along with general vessel traffic. For bowhead whales, subsistence activities have also contributed to disturbance. These effects were likely temporary in duration. The intentional use of sound pulses for research and military purposes is increasing and may be having an effect on some whales.

- ***Reasonably foreseeable future external actions.*** Potential adverse effects of disturbance may result from commercial, subsistence, and recreational vessel traffic and would be expected to continue in future years. Intentional use of sound pulses for research and military purposes may grow as new applications are developed.

- ***Cumulative effect.*** The effects of disturbance are considered to be insignificant at the population-level for all whale species in this group. The cumulative condition of disturbance sources are ubiquitous throughout the ranges of these ESA-listed whales, including small contributions from crab fishing vessels, and are likely to be temporary or local in nature and are not expected to result in population-level effects.

4.9.4.3 Bearded seals

Bearded seals are not listed as threatened or endangered under the ESA but are included in this analysis because crab are believed to be a seasonally important part of their diet. The past/present effects on bearded seals are described in the Alaska Groundfish Fisheries Draft Programmatic Supplemental EIS (NMFS 2003b) and summarized below. The predicted direct/indirect effects of the BSAI king and Tanner crab fisheries under the alternative rationalization programs are described in Section 4.3.4 of this document. This section will assess the potential for these effects to interact with other reasonably foreseeable future actions in a cumulative way. Acknowledging the fact that some actions will tend to offset or mitigate others, this cumulative effects analysis seeks to provide an overall assessment of the species' population-level response to its environment, as influenced by the crab fisheries. The effects considered in this analysis are listed in Table 4.9-13.

Mortality

- ***Direct and indirect effects of the proposed action.*** No incidental take of bearded seals has been reported from the BSAI crab fisheries in the past. Although the alternative rationalization programs will likely alter the spatial/temporal prosecution of the fishery, the mortality of bearded seals is expected to remain insignificant at the population level for all alternative rationalization programs.

- ***Past actions with persistent effects.*** Subsistence harvest by Alaska Natives is the largest source of direct mortality and is estimated at about 6,800 bearded seals per year (Angliss and Lodge 2002). Other external actions on bearded seals include the likelihood of low levels of incidental take in the foreign, JV, and domestic groundfish fisheries and low levels of take in the State-managed fisheries. For bearded seal, the BSAI groundfish fisheries take an average of 0.6 seals per year. Self-reported takes from the Bristol Bay salmon drift gillnet fishery in 1990-1993 included 14 mortalities and 31 injuries of bearded seals, although the accuracy of these species identifications is questionable (Angliss and Lodge 2002).

- ***Reasonably foreseeable future external actions.*** Potential adverse effects from State-managed fisheries will likely continue. Subsistence take of bearded seals will likely continue at a similar rate to the baseline condition and is considered a potential adverse effects contributor. Additionally, potential adverse contributions include the loss of fishing gear and other material from fishing and shipping vessels and shoreside processors. An acute or chronic pollution event may result in a potential adverse effect as well. Climatic variability is not expected to result in direct morality. Potential beneficial effects may occur through the MMPA and MPPRCA.

- ***Cumulative effect.*** The incremental contribution of the proposed rationalization program to the overall cumulative effect is insignificant. The cumulative condition is that human-caused mortality of bearded seals will continue to be dominated by subsistence harvest. The contribution of crab and other commercial fisheries to mortality is minimal for this species and not expected to have population-level effects.

Competition for food

- ***Direct and indirect effects of the proposed action.*** Snow crab is an important prey species for bearded seals, especially in winter. Since bearded seals are closely associated with the ice pack in winter, there is very little simultaneous overlap of the species with the fishery. However, the crab fisheries may alter snow crab populations within the range of bearded seals. The extent to which this direct competition affects foraging success of bearded seals has not been investigated and is therefore considered unknown.

- ***Past actions with persistent effects.*** Past effects on bearded seal prey include harvest and bycatch from foreign, JV, and domestic crab and groundfish fisheries. Due to the small amount of spatial/temporal overlap with commercial fisheries in the past, the effects of fisheries on bearded seal prey availability are considered minor compared to natural productivity factors.

- ***Reasonably foreseeable future external actions.*** Future crab and groundfish fisheries are likely to take some bearded seal prey as targeted species or bycatch. Climate change may have either beneficial or adverse effects depending on changes to ice cover and ocean currents in the Bering Sea and the corresponding affect on abundance and distribution of seal prey.

- ***Cumulative effect.*** The cumulative effect of all fisheries on the foraging success of bearded seals, including an unknown contribution from the BSAI crab fisheries, is considered unknown. It is assumed that the effects are minor compared to natural productivity factors but there has been no directed research to address this question. The cumulative condition is therefore unknown but effects of crab and other commercial fisheries are believed to be limited spatially with bearded seal range.

Disturbance

- ***Direct and indirect effects of the proposed action.*** Due to the limited spatial/temporal overlap of the crab fisheries with bearded seal foraging habitat, disturbance of the seals is considered insignificant at the population level.

- ***Past actions with persistent effects.*** Since bearded seals are closely associated with sea ice most of the year, direct interactions with fishing and transport vessels is limited. The primary source of disturbance has likely been related to subsistence harvest activities.

- ***Reasonably foreseeable future external actions.*** A potential adverse effect exists as disturbance from subsistence harvest activities and a limited amount of marine vessel traffic is expected to be similar to the baseline conditions in future years.

- ***Cumulative effect.*** The cumulative effect on bearded seals is considered to be insignificant. The cumulative condition from the contribution of crab and other commercial fisheries to disturbance is very small for this species. Effects are likely temporary and limited in overlap in time and space with commercial and other marine vessels.

Table 4.9-11 Cumulative effects analysis for western stock of Steller sea lions under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external effects					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Other U.S., State, and foreign fisheries	Subsistence harvest and other intentional take	Marine pollution and vessel hazzards	Conservation efforts	Long-term climate variability and regime shift	
Mortality (incidental take and entanglement)	**Insignificant**	Steep population declines from 1970's- to 1990, less steep decline from 1990's. Incidental take in foreign and domestic fisheries. Commercial harvest of pups. Subsistence harvest. Intentional shootings.	<u>Potential adverse contribution-</u> incidental take in groundfish, salmon, and herring fisheries.	<u>Potential adverse contribution-</u> subsistence harvest throughout range of western stock. Intentional shootings.	<u>Potential adverse contribution-</u> loss of fishing gear and other material from all fishing and shipping vessels plus shoreside sources. Acute and/or chronic pollution events, especially involving oil.	<u>Potential beneficial contribution-</u> Endangered Species Act - listed as endangered. Marine Mammal Protection Act. Marine Plastic Pollution Research and Control Act (MPPRCA) (1987).	<u>Not a contributing factor-</u> direct mortality would not be a primary effect of climate change/regime shift.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: the contribution of the crab fisheries is very small as incidental take of Steller sea lions in the crab fisheries is a rare event and is considered a very small part of the human-caused mortality.

Table 4.9-11(Cont.) Cumulative effects analysis for western stock of Steller sea lions under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably foreseeable future external effects: Human-Controlled: Other U.S., State, and foreign fisheries	Human-Controlled: Subsistence harvest and other intentional take	Human-Controlled: Marine pollution and vessel hazzards	Human-Controlled: Conservation efforts	Natural: Long-term climate variability and regime shift	Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
Competition for Food	**Insignificant**	Past harvest of prey by foreign and domestic commercial groundfish fisheries. Past harvest by State-managed salmon and herring fisheries.	Potential adverse contribution- overlap in prey species and fish taken in groundfish, salmon, and herring fisheries.	Not a contributing factor.	Not a contributing factor.	Not a contributing factor.	Potential adverse or beneficial contribution- climate and oceanic fluctuations impact abundance and distribution of prey.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: effects of past fisheries on prey availability likely contributed to steep population decline. Effects on future population trends conditional on prey being a limiting factor in population recovery. The contribution of the crab fisheries is very small.
Disturbance	**Insignificant**	Disturbance from all fishing and transport vessels in species range. Subsistence harvest. Vessel traffic near rookeries and haulouts.	Potential adverse contribution- disturbance from all fishing and non-fishing vessels in species range.	Potential adverse contribution- disturbance from subsistence harvest.	Potential adverse contribution- disturbance from all transport vessels in species range.	Not a contributing factor.	Not a contributing factor.	**Insignificant**- proposed action would not result in significant changes to the baseline condition. Cumulative condition: no-transit zones around rookeries mitigate worst potential disturbance. Disturbance elsewhere is likely temporary and not expected to affect the species at the population level.

Table 4.9-12 Cumulative effects analysis for ESA-listed cetaceans under all EIS alternatives
Includes northern right whale, bowhead whale, blue whale, fin whale, sei whale, humpback whale, and sperm whale.

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably Foreseeable Future External Effects					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Other U.S., State, and foreign fisheries	Subsistence harvest	Marine Pollution and Vessel Hazzards	Conservation efforts	Long-term climate variability and regime shift	
Mortality (incidental take and entanglement)	**Insignificant**	Commercial whaling until mid-1900's decimated all species and led to their listing as endangered under ESA. Subsistence whaling for bowhead whales. Entangle-ment in fishing gear.	Potential adverse contribution- incidental take in State-managed drift and set gill net fisheries. Entangle-ment in fishing gear. Incidental take in Russian driftnet fishery - right whales.	Potential adverse contribution- subsistence harvest for bowhead whales.	Potential adverse contribution- loss of fishing gear and other material from all fishing and shipping vessels plus shoreside sources. Acute and/or chronic pollution events, especially involving oil. Vessel collisions.	Potential beneficial contribution- Endangered Species Act protections. International Whaling Commission management of subsistence take. Marine Mammal Protection Act. Marine Plastic Pollution Research and Control Act (MPPRCA).	Not a contributing factor- direct mortality would not be a primary effect of climate change/regime shift.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: with the exception of bowhead whales, human-caused mortality is expected to be rare. Contribution of crab fisheries to mortality from entanglement is unknown. Subsistence take of bowheads is closely monitored and this species population is believed to be increasing. Risk of mortality in crab fisheries is very small as this fishery occurs primarily in the fall and winter months when most of the ESA-listed whales are not present in BSAI waters.

Table 4.9-12(Cont.) Cumulative effects analysis for ESA-listed cetaceans under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably Foreseeable Future External Effects					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Other U.S., State, and foreign fisheries	Subsistence harvest	Marine Pollution and Vessel Hazzards	Conservation efforts	Long-term climate variability and regime shift	
Competition for Food	**Insignificant**	Past foreign and domestic commercial squid and forage fish fisheries harvest and bycatch of prey.	Potential adverse contribution- little overlap between fisheries and prey species for these whales.	Not a contributing factor.	Not a contributing factor.	Not a contributing factor.	Potential adverse or beneficial contribution- climate and oceanic fluctuations impact abundance and distribution of prey.	**Insignificant**- proposed action would not result in significant changes to the baseline condition. Cumulative condition: recovery of these species does not appear to be food limited and no human caused factors are likely to alter their prey availability. Bycatch and harvest of whale prey in all fisheries is very small as this fishery occurs primarily in the fall and winter months when most of the ESA-listed whales are not present in BSAI waters.

Table 4.9-12(Cont.) Cumulative effects analysis for ESA-listed cetaceans under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably Foreseeable Future External Effects					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Other U.S., State, and foreign fisheries	Subsistence harvest	Marine Pollution and Vessel Hazzards	Conservation efforts	Long-term climate variability and regime shift	
Disturbance	**Insignificant**	Commercial fishery and transport vessels. Subsistence harvest for bowheads. Research and military use of sound pulses.	<u>Potential adverse contribution-</u> disturbance from all fishing vessels in species range.	<u>Potential adverse contribution-</u> disturbance from subsistence harvest of bowhead whales.	<u>Potential adverse contribution-</u> disturbance from all transport vessels in species range.	Not a contributing factor.	Not a contributing factor.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: disturbance is likely temporary and is not expected to affect any of these species at the population level. Disturbance occurs through out the range of these whales and already includes a small contribution from crab vessels and this fishery occurs primarily in the fall and winter months when most of the ESA-listed whales are not present in BSAI waters.

Table 4.9-13 Cumulative effects Analysis for Bearded Seal under all EIS Alternatives

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably Foreseeable Future External Effects: Human-Controlled: Other U.S., State, and Foreign Fisheries	Human-Controlled: Subsistence harvest	Human-Controlled: Marine pollution and vessel hazzards	Human-Controlled: Conservation Efforts	Natural: Climate Change and Regime Shift	Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
Mortality (incidental take and entanglement)	**Insignificant**	Subsistence harvest.	Potential adverse contribution- rare incidental take in coastal net fisheries and groundfish trawl fisheries.	Potential adverse contribution- subsistence harvest in Alaska averages 6,800 bearded seals per year.	Potential adverse contribution- loss of fishing gear and other material from all fishing and shipping vessels plus shoreside sources. Acute and/or chronic pollution events, especially involving oil.	Potential beneficial contribution- Marine Mammal Protection Act (1972). Marine Plastic Pollution Research and Control Act (MPPRCA) (1987).	Not a contributing factor - direct mortality would not be a primary effect of climate change/regime shift.	**Insignificant-** proposed action would not result in significant changes to the baseline condition. Cumulative condition: population estimates under review but no evidence of decline. PBR is not available but believed to be stable. Human-caused mortality expected to continue to be dominated by subsistence harvest. Contribution of crab and other commercial fisheries to mortality is very small for this species.
Competition for Food	**Unknown**	Past foreign and domestic commercial crab fisheries harvest of prey.	Potential adverse contribution- overlap in prey species harvested in foreign and subsistence fisheries , bycatch of crab in groundfish fisheries.	Not a contributing factor.	Not a contributing factor.	Not a contributing factor.	Potential adverse or beneficial contribution- climate and oceanic fluctuations impact abundance and distribution of prey.	**Unknown**- impact of crab and other commercial fisheries on foraging success of bearded seals is unknown. Cumulative condition: unknown but effects of crab and other commercial fisheries are believed to be limited spatially with bearded seal range.

Direct/indirect effects of proposed action	Significance of direct/indirect effects	Past actions with persistent effects	Reasonably Foreseeable Future External Effects					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Other U.S., State, and Foreign Fisheries	Subsistence harvest	Marine pollution and vessel hazzards	Conservation Efforts	Climate Change and Regime Shift	
Disturbance	**Insignificant**	Disturbance from past commercial fishery and transport vessels. Subsistence harvest.	<u>Potential adverse contribution-</u> disturbance from all fishing and transport vessels in species range.	<u>Potential adverse contribution-</u> disturbance from subsistence harvest.	Not a contributing factor.	Not a contributing factor.	Not a contributing factor.	**Insignificant**- proposed action would not result in significant changes to the baseline condition. Cumulative condition: effects are likely temporary and limited in spatial/temporal overlap with seal habitat. The contribution of crab and other commercial fisheries to disturbance is very small for this species.

4.9.5 Cumulative effects analysis for BSAI ecosystem

The past and present effects on the BSAI ecosystem as they relate to king and Tanner crab are described in Section 3.1 of this document. The areas of concern are the eastern Bering Sea encompassing the extensive shelf of Bristol Bay along the Alaskan Peninsula, north to St. Matthew Island, and seaward to the shelf break that runs southeast to northwest (Figure 3.1-1). Other documents discussing the ecosystem are incorporated by reference in Section 3.1 and summarized below. The predicted direct/indirect effects of the BSAI king and Tanner crab fisheries under the alternative rationalization programs are described in Section 4.3.4. This section will assess the potential for these effects to interact with other reasonably foreseeable future actions in a cumulative way. Acknowledging the fact that some actions will tend to offset or mitigate others, this cumulative effects analysis seeks to provide an overall assessment of the ecosystem as it is influenced by the crab fisheries. The effects considered in this analysis are listed in Table 4.9-14. In the interest of clarity and brevity, only the most important factors will be discussed as they pertain to the cumulative effects conclusion.

All alternatives will be examined together since no changes in total removals of crab from the ecosystem will result from any of the alternatives. The only potential variation is the time and/or location at which crab are removed. The alternative analysis will examine three main effects categories: predator-prey relationships, energy flow and balance, and diversity. For a more detailed discussion of these effects, refer to Section 3.1 of this document and Section 3.10 of the Alaska Groundfish Fisheries Draft Programmatic Supplemental EIS (NMFS 2003b).

Predator/prey relationships

Change in crab prey availability

Prey species consumed by king and Tanner crab vary with the life stage, size, depth inhabited, and species. During crab planktonic stages, the larvae consume mainly phytoplankton and zooplankton**.** Once the crab settle, most of their prey species are benthic invertebrates, and may include protozoa, hydroids, crabs, worms, clams, mussels, snails, brittle stars, sea stars, sea urchins, sand dollars, barnacles, fish parts and algae (Livingston 1993). Generally, prey availability is assessed by evaluating the trends in the biomass and evaluating prey species population models. However, benthic invertebrate abundance, biomass, and distribution data are not available at this time.

- ***Direct and indirect effects of the proposed action.*** Due to the relatively small amounts of crab prey species taken as bycatch, the direct/indirect effects of the crab fisheries on king and Tanner prey availability are considered insignificant for all alternative rationalization programs .

- ***Past actions with persistent effects.*** Little baseline information exists on crab prey abundance and distribution. Populations of benthic prey species have likely been adversely affected by all past fisheries that use bottom-contact gear (e.g., groundfish bottom trawls, groundfish and crab pot gear, scallop dredging), at least in localized areas (see Section 3.3.1.3). Although research has not yet been conducted, it is also possible that benthic prey species have been either positively or negatively affected by climatic fluctuations and decadal regime shifts. Marine pollution also may potentially impact crab prey availability and/or quality (see Section 3.3.3).

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue in the future and are considered future external actions in this analysis. In addition, competition from invasive species, such as the European green crab, known to prey heavily on bivalves, [http://www.wa.gov/wdfw/fish/ans/greencrab.htm#impacts], may further reduce prey availability if their abundance and distribution were to overlap with king and Tanner crab habitat.

- ***Cumulative effect.*** Due to the relatively small amounts of crab prey species taken as bycatch in the BSAI crab fisheries, the incremental contribution of the proposed rationalization programs to the overall cumulative effect status for changes in crab prey availability is considered insignificant. Information regarding crab prey species abundance and distribution is unavailable at this time and the potential effects of various commercial bottom gear fisheries, climatic fluctuations and regime shifts, marine pollution, and invasive species on crab forage success are uncertain.

Removal of Crab Predators

As with crab prey species, the predators of crab vary with the life stage, size, depth inhabited and species. Predator species at the planktonic stage include pelagic fish, such as pollock, salmon and herring. As crab species grow in size, predators include Pacific cod, rock sole, yellowfin sole, pollock, octopus, sculpin, bearded seals, sea otters, halibut and other flatfish, eel pouts, and skates (Livingston 1993, Tyler and Kruse 1997 and Orlov 1998).

Removal of top predators is assessed by evaluating the trophic level of catch relative to the trophic levels of the crab biomass, bycatch levels of sensitive top predator species, and a qualitative evaluation of the potential for harvest levels to cause one or more top-level predator species to fall below biologically acceptable limits (e.g., MSST) (NMFS 2003b).

- ***Direct and indirect effects of the proposed action.*** Crab pots usually take some crab predators as bycatch, including octopi and some groundfish species. Pacific cod, Pacific halibut, yellowfin sole and sculpin account for the greatest proportion of estimated crab pot bycatch. However, all of these species have exhibited relatively stable biomass and bycatch numbers are insignificant in comparison with the average annual harvest (bycatch in the case of non-target species such as sculpins) taken by the NOAA groundfish target fisheries (NMFS 2003b). Furthermore, bycatch levels are believed to be minor compared to predator species abundance. Incidental catch of crab predators in the crab fisheries is not expected to be high enough to result in the biomass of one or more top predator species falling below the minimum biologically acceptable limit. Therefore, the effect of the crab fisheries on crab predator abundance is considered insignificant under all alternative rationalization programs.

- ***Past actions with persistent effects.*** Groundfish fisheries have taken substantial numbers of crab predators in the form of target fish and bycatch, including octopi, and skates. Planktivorous fish, seabirds, and marine mammals that may prey on crab larvae have also been negatively affected to some degree by commercial and subsistence harvests as either targeted species or bycatch. However, Livingston et. al (1999) and Queirolo et al. (1995) conducted studies to determine if fishing down the food web (Pauly et al. 1998) was occurring in the groundfish fisheries from the 1960's to the present. These studies found that the trophic level of the target groundfish species in the BSAI and GOA has been relatively high and stable over the last thirty years or more (NMFS 2003b). Subsistence harvest of bearded seals, a main predator of Tanner crab, have occurred in the past and are likely to continue at approximately 6,800 seals per year (Angliss and Lodge 2002). Thus, although large numbers of crab predator species are removed as directed catch and bycatch in the federal and state commercial groundfish fisheries, IPHC fisheries, and through subsistence harvests, overall, these removals are considered to be insignificant. Removal of crab predators in the short-term and/or in specific areas is potentially beneficial to local crab abundance and recruitment. Evidence suggests that past climatic fluctuations and regime shifts have influenced the abundance and distribution of crab predators either positively or negatively, depending on the species (NMFS 2003b). Marine pollution is considered a potential adverse effect on crab predator abundance. In turn, this could benefit crab abundance, although this affect is likely negligible.

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue in the future and are considered future external actions for this analysis.

- ***Cumulative effect.*** The proposed rationalization programs will not result in significant changes to harvest level-setting processes, current closures and protection measures, or total removal of crab. Incidental catch of crab predators by crab fisheries is not expected to result in the biomass of one or more top predator species falling below the minimum biologically acceptable limit and the incremental contribution of the proposed action to the overall cumulative effect status is insignificant. The recruitment of crab is believed to be determined primarily by oceanographic factors rather than predation on larva and juveniles. These oceanographic factors strongly influence the availability of planktonic larva and post-settlement juveniles to potential predators. The population-level effects on crab resulting from removal of groundfish and other predator stocks are uncertain. In addition, few crab predator populations, other than targeted groundfish species, are surveyed for abundance or trends.

Introduction of Non-native Species

- ***Direct and indirect effects of the proposed action.*** Crab vessels remaining in Alaska year round are not likely to contribute to the introduction of non-native species. However, many vessels travel outside Alaska for other fisheries or for repairs and may pick up non-native species that have been introduced or spread to those waters. Since the size of the crab fishing fleet is not likely to increase under any of the alternatives, the level at which fishing-vessels introduce non-native species through ballast water exchange or release of hull-fouling organisms is not expected to change from current baseline conditions. Therefore, the risk of the crab fisheries introducing non-native species is considered insignificant.

- ***Past actions with persistent effects.*** Numerous pathways have been identified for the spread of non-native species, including the release of ballast water picked up in non-Alaskan waters, attachment of barnacle-like organisms to hulls in foreign ports by tourist operations, commercial shipping and fishing vessels, and release or escapes from fish farming (e.g., Atlantic salmon in Alaska, Washington, and Canada). So far, there have been 24 non-indigenous species of plants and animals documented in Alaskan waters (Fay 2002). Studies have identified oil tankers as the primary source for these introductions, although cruise ships and fishing vessels are also identified as a threat by the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). The largest threat to the Alaskan crab fisheries is the potential introduction of the European green crab, which could spread to Alaskan waters after being introduced to ports in Washington, Oregon, and British Columbia, Canada (Washington Department of Fish and Wildlife, Aquatic Nuisance Species, http://www.wa.gov/wdfw/fish/ans/greencrab.htm#invasion). Establishment of Atlantic salmon runs in Alaskan waters could also have an adverse affect on crab fisheries since salmon prey on crab at the planktonic stage, however, researchers are more concerned over the effects Atlantic salmon could have on the Pacific salmon populations (Rue and Gaudet 2002 http://www.state.ak.us/adfg/geninfo/special/AS/docs/AS_white2002.pdf). Climate and oceanographic changes, particularly warming trends and El Niño Southern Oscillation (ENSO) events, may assist the spread of non-native species to more northern areas if those species are normally limited by colder water temperatures.

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue in the future and are considered future external actions in this analysis.

- ***Cumulative effect.*** Many pathways for the introduction of non-native species exist, including accidental transport on vessels associated with the crab fisheries. The effects of non-native species on crab populations through competition or alteration of food webs are potentially significant, but the incremental contribution of the crab fisheries to the overall cumulative effect status is insignificant. This conclusion would apply to all proposed rationalization programs as well.

Energy flow and balance

Energy/biomass removal

Fishing may alter the amount of energy flow into and out of an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal back into the sea.

- ***Direct and indirect effects of the proposed action.*** Crab harvested by the crab fisheries can be considered a removal of energy from the ecosystem, however, the amount of energy/biomass removed by the crab fisheries under all alternative rationalization programs is predicted to be less than one percent of the eastern Bering Sea ecosystem (Trites et al. 1999) and is therefore considered insignificant.

- ***Past actions with persistent effects.*** Harvest and bycatch of target and non-target species by Federal and State groundfish, salmon, scallop, and shrimp fisheries, halibut fisheries, past commercial marine mammal harvests, and subsistence harvests have all taken energy/biomass from the BSAI ecosystem on a continued basis. Climatic fluctuations and regime shifts have influenced biomass levels, which then indirectly influence the level of human removals.

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue in the future and are considered future external actions, except commercial harvests of marine mammals, which has been eliminated in Alaskan waters.

- ***Cumulative effect.*** Although an exact percentage of energy/biomass removal cannot be predicted for the area of concern, the combined removal by crab fisheries, domestic groundfish fisheries, State fisheries, halibut fisheries, and subsistence harvests is predicted to be only a small portion of the total system energy. Total removals by humans are not likely to affect overall system biomass, production, or energy cycling outside the range of natural variability. Thus, the incremental contribution of the proposed alternatives is insignificant to the overall cumulative effect status.

Energy/biomass redirection

Fisheries can redirect energy by discarding and returning fish processing waste to the system. These practices take energy sources and potentially provide them to different parts of the ecosystem relative to the natural state. For example, discards of dead flatfish or small benthic invertebrates might be consumed at the water surface by scavenging birds, which would normally not have access to those energy sources (NMFS 2003b). The total crab offal and discard production, as a percentage of the unused detritus (decaying organic matter) already going to the bottom, has not been estimated. Crab are discarded either at sea, within areas of crab populations, or as processing waste. The effects of processing waste on the environment are discussed in Sections 3.3.6 and 4.3.5.

- ***Direct and indirect effects of the proposed action.*** The crab fisheries are predicted to redirect energy in the ecosystem by making processing wastes available to species that would not normally have access to these resources. The amount of energy redirected by the crab fisheries is considered minimal compared to natural sources of detritus that are available to scavenging species. The effects are therefore considered to be insignificant under all alternative rationalization programs.

- ***Past actions with persistent effects.*** Discards and offal production from fish and crab processing have produced changes to energy distribution in the BSAI by making energy/biomass from benthic or pelagic organisms available to scavenging birds, marine mammals, fish, and invertebrates that would not normally have access to that energy. Disruption of benthic habitat from bottom contact fishing gear has also likely exposed benthic species to unnatural levels of predation by removing sheltering structures. This results in an increased flow of energy to predatory and scavenging species. The release of graywater and refuse by commercial freighters, tankers, and cruise ships has also contributed external energy to the system. In addition, climatic fluctuations have the potential to influence energy cycling. In general, warming trends are expected to increase the rate at which energy conversion occurs whereas cooling trends are expected to decrease energy conversion rates.

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue in the future and are considered future external actions in this analysis. Present and future fisheries are likely to continue redistributing energy via the mechanisms discussed above. Considering ongoing efforts in many fisheries to reduce bycatch and improve processing efficiency, the overall amount of fishery wastes released into the marine environment may decrease in the future relative to the baseline condition.

- ***Cumulative effect.*** The combined total of discards, offal, and gear-related mortality from BSAI crab fisheries, in addition to inputs from external sources, are not likely to produce long-term changes in energy/biomass redirection outside its range of natural variability and the incremental contribution of the proposed action to the overall cumulative effect status is insignificant.

Biological Diversity

Change in species diversity

Species-level diversity can be altered if fishing removes a single species or group of species from the ecosystem. Significance thresholds for effects of fishing on species diversity are defined as catch removals high enough to cause the biomass of one or more species (target or non-target) to fall below, or to be kept from recovering from levels already below, minimum biologically acceptable limits.

- ***Direct and indirect effects of the proposed action.*** Bycatch levels of all non-target species are minimal and gear effects on benthic habitats are considered relatively minor in the BSAI crab fisheries. Thus, potential effects on species diversity are considered insignificant to non-crab species under all alternative rationalization programs. However, overexploitation of certain crab species by these fisheries could have a significant adverse impact on crab populations in localized areas, and may decrease the species diversity within a particular community. This effect may have already occurred in areas with depressed and/or rebuilding crab populations.

- ***Past actions with persistent effects.*** Past foreign and domestic BSAI fisheries, including groundfish, crab, and scallop, over exploited particular target stocks and removed unknown numbers of non-target species as bycatch. The impacts of most fisheries on species diversity, other than target fish, have not been examined. Commercial whaling in the BSAI, until the mid-1900's, dramatically reduced populations of baleen and sperm whales, with right whales almost becoming extinct. Commercial feather hunting of short-tailed albatross on nesting grounds in Japan during the early 1900's almost eliminated this species, which once numbered in the millions in the BSAI. Incidental take of black-footed and Laysan albatross in longline fisheries has also experienced population-level effects. Studies in other fishing grounds have linked climate with biological community composition (Jennings and Kaiser 1998, Livingston and Tjelmeland 2000). These studies indicate that climate fluctuations and fishing pressure can alter species composition and productivity, although studies have not been completed specific to the BSAI region.

- ***Reasonably foreseeable future external actions.*** Since commercial whaling and feather hunting have been outlawed, the main threat to species diversity in the future is through the direct removal or incidental take of sensitive species, such as sharks. The introduction of non-native species through several potential pathways (described above) may also result in a reduction in species diversity in the future, as has been documented extensively in many aquatic and terrestrial environments worldwide.

- ***Cumulative effect.*** Regulatory statutes and laws, such as the ESA, provide protection and mitigation for species that are or may be threatened or endangered. Although this law may help reduce species extinctions, dramatic reductions in species populations could have significant ecosystem-level effects. There has been minimal research on benthic invertebrates and non-target fish species that may be affected by fishing pressure with implications for species diversity. Additionally, the introduction of non-native species coupled with potential climate changes/regime shifts could have significant adverse effects on species diversity. Although the incremental contribution of the crab fisheries to the overall cumulative effect status is insignificant, the cumulative condition for species diversity is currently unknown but potentially adverse depending on the continuation of other future actions (both human-controlled and natural).

Change in Functional (Trophic and Structural) Diversity

Fishing can alter functional diversity if it results in removal or depletion of a trophic guild member, thereby changing the distribution of biomass within a trophic guild. Functional diversity, from a structural 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. Significance thresholds are defined as catch removals resulting in a change in functional diversity outside the range of natural variability observed for the system. Indicators of the possible magnitude of effects include qualitative evaluation of guild or size diversity changes relative to fishery removals, bottom gear effort changes that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild.

- ***Direct and indirect effects of the proposed action.*** Crab fisheries are not expected to change the overall diversity of trophic guilds in the BSAI through harvest, although pot gear used in the crab fisheries has the potential to adversely impact functional diversity through the removal or mortality of living benthic habitat. Crab fisheries and other factors, both human-controlled and natural, have substantially reduced total crab biomass when compared to the un-fished environment. Therefore, they have likely altered the proportion of guild members, with other guild members becoming more abundant as crab species have become less abundant. Likewise, motile benthic invertebrates, those species which prosper in disturbed environments, could also increase in abundance. Thus, the most likely effect of these fisheries is altering local abundance of guild members and potentially altering species compositions in localized communities. This effect likely occurred in areas with currently depressed crab populations. However, it is unlikely that removals by crab fisheries are of a magnitude resulting in a decline of overall trophic and structural diversity and crab fisheries are considered insignificant to changes in functional diversity.

- ***Past actions with persistent effects.*** Commercial whaling almost eliminated a major sector of planktivores in the BSAI. Foreign and domestic fisheries may have affected trophic diversity through large removals of target species and high bycatch rates of biologically sensitive species (e.g., long-lived, slow-growing species). However, the main fisheries effect appears to be the change in species proportions rather than a loss of diversity (Livingston et al. 1999). Past fisheries have also had adverse effects on structural habitat (HAPC biota) through the use of bottom gear, although the magnitude of these effects are largely unknown. As described for the crab fisheries, past fisheries could have influenced benthic community species composition and/or abundance through the use of bottom gear. For example, motile benthic invertebrates, those species which prosper in disturbed environments, could have increased in abundance. Climatic fluctuations may also impact functional diversity by influencing the abundance and distributions of members within a trophic guild.

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue into the future, with the exception of commercial whaling. The potential for commercial, and subsistence fisheries to affect trophic diversity will remain in the future, especially for localized areas. The introduction of non-native species through several potential pathways (described above) may also result in a reduction in guild diversity in the future, as has been documented extensively in many aquatic and terrestrial environments worldwide. Additionally, the potential for establishing populations of non-native species could be facilitated by favorable climatic conditions.

- ***Cumulative effect.*** There has been minimal research on benthic invertebrates and non-target fish species potentially affected by fishing pressure with implications for functional diversity. The introduction of non-native species coupled with potential climate changes/regime shifts could have significant effects on functional diversity. Although the incremental contribution of the crab fisheries to the overall cumulative effect status is insignificant, the cumulative condition for functional diversity is currently unknown but potentially adverse depending on the continuation of other future actions (both human-controlled and natural).

Change in genetic diversity

Fishing can alter genetic diversity by selectively removing faster growing fish or spawning aggregations having unique genetic characteristics that differ from other spawning aggregations.

- ***Direct and indirect effects of the proposed action.*** The potential effects of the crab fisheries on genetic diversity of crab populations through selection for males of minimum size, targeting of mating aggregations, or highgrading for shell quality have not been examined. Through rationalization of the crab fisheries, it is possible that as soak time and corresponding catch per pot increases, the opportunity for selective fishing (highgrading) also increases. However, it is difficult to predict the consequences of rationalization and highgrading on crab diversity. Crab genetic diversity would most likely be impacted by overexploitation in the fisheries. Overexploitation has the potential to lower genetic diversity of local stocks and may have already occurred in those areas with depressed or rebuilding crab populations. However, genetic studies on BSAI crab populations are incomplete and the potential effects on overall genetic diversity remain unknown. Bycatch levels of all non-target species within the crab fisheries are minimal and gear effects on benthic habitats are considered relatively minor. Due to insufficient information on genetic diversity of non-target species, the effects of crab fisheries on non-crab genetic diversity is also unknown for all alternative rationalization programs.

- ***Past actions with persistent effects.*** Large removals of fish from the BSAI by past domestic, JV, and foreign groundfish fisheries, State fisheries, halibut , and subsistence fisheries have potentially impacted the genetic diversity of various species. However, data is not available to quantify these effects. Overexploitation of certain populations, such as the Bogoslof pollock stocks, results in lower genetic diversity, although information is not available to measure these effects and identify population-level impacts. Climatic fluctuation and regime shifts have the ability to influence population size and genetic composition, but there has been little directed research on this topic. Selectivity within fisheries for particular body type or gender potentially affects genetic diversity in target species populations.

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue in the future with the addition of the introduction and establishment of non-native species, such as the European green crab. Current and future fishery management has attempted to distribute fishing effort over space and time in order to reduce fishing pressure on spawning aggregations. These tactics may reduce the risk of altering genetic diversity within target and non-target species.

- ***Cumulative effect.*** The baseline variability in genetic diversity is unknown for most species in the BSAI ecosystem. Many factors are likely to influence genetic variability, however, due to the inability to determine the baseline condition, the potential cumulative effects on genetic diversity are considered unknown. This conclusion is the same for all alternative rationalization programs.

Table 4.9-14 Cumulative effects analysis for the BSAI ecosystem: Status Quo and Alternative Rationalization Programs

Direct/indirect effects of proposed action	Significance of Direct/ Indirect Effect	Past actions with persistent effects	Reasonably foreseeable future external actions: Human-Controlled: Subsistence hunting and fishing	Human-Controlled: Federal & State groundfish fisheries	Human-Controlled: scallop & shrimp fisheries	Human-Controlled: State salmon fisheries	Human-Controlled: halibut fishery	Human-Controlled: Marine pollution and transport vessels	Natural: Climate change and regime shift	Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
Change in crab prey availability	**Insignificant**	Bottom-contact fishing gear; marine pollution; climatic variability.	Not a contributing factor.	Potential adverse contribution- mortality of prey and disruption of habitat by ground contact fishing gear.	Potential adverse contribution- mortality of prey and disruption of habitat by scallop dredges.	Not a contributing factor.	Not a contributing factor.	Potential adverse contribution- acute and/or chronic toxicity could alter prey composition and abundance, introduction of non-native species.	Potential adverse or beneficial contribution- climate change could alter survival and productivity of prey species.	**Insignificant-** bycatch of crab prey in crab fisheries is minimal. Cumulative condition: abundance estimates of crab prey species are not available and intensity of various impacts has not been evaluated.
Removal of crab predators	**Insignificant**	Direct catch and bycatch of groundfish, octopus, sharks, and planktivores that prey on crab larva; climatic variability.	Potential beneficial contribution- catch of crab predators; may be beneficial on localized scale, overall negligible impact.	Potential beneficial contribution- large-scale removal of crab predators, may be beneficial on localized scale, overall negligible impact.	Not a contributing factor.	Potential beneficial contribution removal of planktonic and juvenile crab predators, may be beneficial on localized scale, overall negligible impact.	Potential beneficial contribution- removal of crab predators, may be beneficial on localized scale, overall negligible impact.	Potential beneficial contribution- acute and/or chronic toxicity could alter predator composition and abundance.	Potential adverse or beneficial contribution- climate change could alter survival and productivity of predator species either positively or negatively.	**Insignificant-** bycatch of crab predators in crab fisheries is minimal. Cumulative condition: effects of predator removal on population dynamics of crab species are uncertain; oceanographic factors may influence recruitment of crab.

Table 4.9-14(Cont.) Cumulative effects analysis for the BSAI ecosystem: Status Quo and Alternative Rationalization Programs

Direct/indirect effects of proposed action	Significance of Direct/ Indirect Effect	Past actions with persistent effects	Reasonably foreseeable future external actions							Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled						Natural	
			Subsistence hunting and fishing	Federal & State groundfish fisheries	scallop & shrimp fisheries	State salmon fisheries	halibut fishery	Marine pollution and transport vessels	Climate change and regime shift	
Introduction of non-native species	**Insignificant**	Ballast water release and hull-fouling of marine vessels; climatic variability.	Not a contributing factor.	Potential adverse contribution- non-native Ballast and hull-fouling organisms from vessels outside Alaska.	Potential adverse contribution- non-native Ballast and hull-fouling organisms from vessels outside Alaska.	Potential adverse contribution- non-native Ballast and hull-fouling organisms from vessels outside Alaska.	Potential adverse contribution- non-native Ballast and hull-fouling organisms from vessels outside Alaska.	Potential adverse contribution- non-native Ballast and hull-fouling organisms from vessels outside Alaska.	Potential adverse contribution- warming trends may favor non-native species.	**Insignificant-** effects from crab fisheries are minor compared to other sources of introduction. Cumulative condition: effects of non-native species on crab populations through competition or alteration of food webs may be significant; Potential for European green crab to spread to the Aleutian Islands.
Energy/ Biomass removal	**Insignificant**	Direct catch and bycatch of crab, target fish species, and non-target species; commercial whaling; subsistence activities.	Potential adverse contribution- hunting of marine mammals and fisheries; overall removal is considered negligible.	Potential adverse contribution- directed fisheries; overall removal is considered negligible.	Potential adverse contribution- directed fisheries; overall removal is considered negligible.	Potential adverse contribution- directed fisheries; overall removal is considered negligible.	Potential adverse contribution- directed fisheries; overall removal is considered negligible.	Not a contributing factor- potential redistribution but no energy removal from system.	Not a contributing factor- potential redistribution but no energy removal from system.	**Insignificant-** removals from crab fisheries are relatively minor when compared to total system energy. Cumulative condition: total fishery removals estimated at less than 1 percent of the total system energy/biomass; total removals by humans will not result in changes outside the range of natural variability.

Table 4.9-14(Cont.) Cumulative effects analysis for the BSAI ecosystem: Status Quo and Alternative Rationalization Programs

Direct/indirect effects of proposed action	**Significance of Direct/ Indirect Effect**	**Past actions with persistent effects**	**Reasonably foreseeable future external actions**							**Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)**
			Human-Controlled						Natural	
			Subsistence hunting and fishing	**Federal & State groundfish fisheries**	**scallop & shrimp fisheries**	**State salmon fisheries**	**halibut fishery**	**Marine pollution and transport vessels**	**Climate change and regime shift**	
Energy/ Biomass redirection	**Insignificant**	Fish and crab processing discards and offal; release of graywater and refuse from marine vessels; climatic variability.	Potential adverse contribution- discards and offal production.	Potential adverse contribution- discards and offal production; bottom gear impacts.	Potential adverse contribution- discards and offal production; bottom gear impacts.	Potential adverse contribution- discards and offal production.	Potential adverse contribution- discards and offal production.	Potential adverse contribution- pollution, graywater and refuse release from marine vessels.	Potential adverse or beneficial contribution- effects on energy cycling in the ecosystem.	**Insignificant**- crab fisheries will not result in long-term changes in energy/biomass redirection outside the range of natural variability. Cumulative condition: total crab offal and discard production has not been estimated.
Change in species diversity	**Insignificant**	Fishery removals and disturbance of benthic organisms; commercial whaling; commercial feather hunting; incidental take of seabirds in fishing gear.	Potential adverse contribution- removals of species occurs; harvest level-setting processes incorporate population status.	Potential adverse contribution- target species managed for sustainability; effects on non-target fish, benthic organisms, and seabirds.	Potential adverse contribution- target species managed for sustainability; effects on non-target fish and benthic organisms.	Potential adverse contribution- target species managed for sustainability; effects on non-target fish and seabirds.	Potential adverse contribution- target species managed for sustainability; effects on non-target fish and seabirds.	Potential adverse contribution- introduction of non-native species from hulls and ballast water.	Potential adverse or beneficial contribution- effects on productivity and distribution of individual species.	**Insignificant-** removal of non-crab species by crab fisheries is minimal. Cumulative condition: species within the BSAI have been listed as threatened or endangered; minimal research on diversity of benthic invertebrate and non-target fish species exists.

Table 4.9-14(Cont.) Cumulative effects analysis for the BSAI ecosystem: Status Quo and Alternative Rationalization Programs

Direct/indirect effects of proposed action	Significance of Direct/ Indirect Effect	Past actions with persistent effects	Reasonably foreseeable future external actions							Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled						Natural	
			Subsistence hunting and fishing	Federal & State groundfish fisheries	scallop & shrimp fisheries	State salmon fisheries	halibut fishery	Marine pollution and transport vessels	Climate change and regime shift	
Change in functional (trophic and structural) diversity	**Insignificant**	Climatic variability; commercial whaling; commercial fishing; bottom fishing gear.	Potential adverse contribution- harvests may not affect trophic diversity; may alter guild member proportions and/or localized community composition.	Potential adverse contribution- overharvest of slow-growing species with relatively low productivity; bottom gear impacts.	Potential adverse contribution- alter guild member proportions and/or localized community composition; bottom gear impacts.	Potential adverse contribution- alter guild member proportions and/or localized community composition.	Potential adverse contribution- alter guild member proportions and/or localized community composition.	Potential adverse contribution- introduction of non-native species.	Potential adverse contribution- effects on guild member proportions and/or community composition.	**Insignificant-** removal of non-crab species by crab fisheries is minimal. Cumulative condition: fisheries and other factors influence the abundance of guild members and may alter the composition of localized communities; minimal information exists on the abundance and diversity of benthic invertebrates and non-target fish species with implications for functional diversity.
Change in genetic diversity	**Unknown**	Climatic variability; highly selective fisheries.	Potential adverse contribution potential for localized depletion of sub-populations.	Potential adverse contribution localized depletion of sub-populations of target and non-target species; bottom gear impacts.	Potential adverse contribution localized depletion of sub-populations; bottom gear impacts.	Potential adverse contribution localized depletion of sub-populations; genetic diversity incorporated into management of salmon.	Potential adverse contribution localized depletion of sub-population.	Potential adverse contribution introduction of non-native species.	Potential adverse contribution effects on particular morphic types; enabling spread of non-native species.	**Unknown-** genetic studies on BSAI crab populations are incomplete and the potential effects on overall genetic diversity remain unknown. Cumulative condition: baseline variability in genetic diversity is unknown for all crab populations and most target and non-target species.

4.9.6 Cumulative effects analysis on the physical environment in vicinity of crab processors

The past/present effects of the BSAI king and Tanner crab fisheries on water quality and the benthic substrate as a result of crab processing are described in Section 3.3.6 of this document. The predicted direct/indirect effects of the BSAI crab fisheries under the status quo and alternative rationalization programs are described in Section 4.3.5 and summarized below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. Acknowledging the fact that some events will tend to offset or mitigate other effects, this cumulative effects analysis seeks to provide an overall assessment of the ecosystem as it is influenced by the crab fisheries. The effects considered in this analysis are listed in Table 4.9-15. In the interest of clarity and brevity, only the most important factors will be discussed as they pertain to the cumulative effects conclusion.

<u>Accumulation of Benthic Waste Piles</u>

- ***Direct and indirect effects of the proposed action.*** Accumulations of crab shells from processing waste streams are expected to continue under all alternative rationalization programs and will likely degrade localized areas of benthic substrate by smothering. Such accumulations are regulated and monitored by the EPA and the ADEC and are considered insignificant under the status quo conditions. The alternative rationalization programs would tend to disperse processing effort over time and have the potential to decrease water quality concerns. The effects of the crab fisheries on the benthic substrate through accumulation of waste piles is therefore considered insignificant for all alternative rationalization programs.

- ***Past actions with persistent effects.*** Accumulations of slowly biodegrading shells and fish bones occur in numerous locations of the BSAI as a result of past crab and fish processing in protected harbors. Documentation of the size and dispersal of these waste piles exists in only a few locations associated with shore-based processors. The size and persistence of waste piles is a function of waste stream characteristics such as composition, particle size, and discard rate as well as the volume and speed of flushing currents available to disperse the waste. The Clean Water Act (1972) allowed for the establishment of standards and regulations that mitigate the cumulative effects of processing waste discharge.

- ***Reasonably foreseeable future external actions.*** All past effects listed above are likely to continue in the future. Permitting, monitoring, and enforcement of Clean Water Act regulations will remain under the jurisdiction of the EPA and ADEC. Processing facilities, both floating and shore-based, are generally located where receiving waters for their discharges are relatively quiescent. Short of completely eliminating the discharges, their permitting and monitoring per Clean Water Act regulations can only restrict the deleterious effects of the discharges to the immediate vicinity of the processor. So, while the resulting waste piles do create very localized negative effects, they do not constitute a significant overall environmental impact.

- ***Cumulative effect.*** Since the contribution of waste discharge from unregulated sources (sport and subsistence fisheries) is small and commercial processing waste streams can be regulated by discharge permits and required monitoring per regulations of Clean Water Act by EPA and ADEC, the cumulative effects of processors on benthic substrates are considered insignificant.

Concentration of biological oxygen demand

- ***Direct and indirect effects of the proposed action.*** Crab processing under status quo is accomplished in a very short time frame since crab must be processed live and the crab seasons typically last only a week or two. Discharge permits limit the daily amount of BOD that can be discharged in any given area based on total expected loads, flushing rates, and other local variables. Assuming that EPA and ADEC continue to monitor and enforce discharge permits, the total impact of crab processing is considered insignificant under the status quo (Alternative 1). Since the alternative rationalization programs would tend to disperse processing effort over time, they have the potential to decrease the daily discharge rate of BOD and are thus also considered insignificant.

- ***Past actions with persistent effects.*** Almost all past and present commercial fisheries have contributed to BOD through processing wastes. In some low-flushing locations such as Dutch Harbor, concentrations of BOD have exceeded the capacity of the system to degrade the waste and the resulting anaerobic conditions have resulted in the production of undesirable gases such as hydrogen sulfide and methane. Emission of these gases has been observed in sufficient quantities to cause skin and eye irritation to divers and to impact fish and invertebrate populations. The Clean Water Act has allowed for mitigation of past problem situations and regulatory limits for future BOD discharges.

- ***Reasonably foreseeable future external actions.*** All fish processing in the BSAI is likely to contribute to BOD in the future. Permitting, monitoring, and enforcement of Clean Water Act regulations will remain under the jurisdiction of the EPA and ADEC.

- ***Cumulative effect.*** Although BOD could contribute to localized problems with water quality in the future, commercial processing waste streams can be regulated by discharge permits and required monitoring per regulations of Clean Water Act by EPA and ADEC. Discharge limitations on offal and resulting BOD from shore-based and floating crab and fish processing facilities should minimize overall water quality degradation with result that the cumulative effects of BOD on water quality in the BSAI are therefore considered insignificant.

Discharge of suspended solids

- ***Direct and indirect effects of the proposed action.*** The contribution of crab processing to suspended solids is regulated through permit programs and is considered insignificant for all alternative rationalization programs.

- ***Past actions with persistent effects.*** All past and present fish and crab processing contribute suspended solids as part of their waste discharges. Suspended solids include both organic and inorganic (sand and shell fragments) materials. While in suspension, these materials increase the turbidity of the water, reduce light penetration, and impair the photosynthetic activity of aquatic plants. Suspended solids may also kill fish or shell fish by causing abrasive injuries, clogging gills and respiratory passages, and promoting the development of noxious conditions through oxygen depletion. The Clean Water Act has allowed for regulatory limits and monitoring of suspended solid discharges from fish processors.

- ***Reasonably foreseeable future external actions.*** All future fish and shell fish processors in the BSAI are likely to contribute suspended solids in their waste streams. Permitting, monitoring, and enforcement of Clean Water Act regulations will remain under the jurisdiction of the EPA and ADEC.

- ***Cumulative effect.*** Although suspended solids could contribute to localized problems with water quality in the future, commercial processing waste streams can be regulated by discharge permits and required monitoring per regulations of Clean Water Act by EPA and ADEC. (Discharge limitations on suspended solids should minimize overall water quality degradation. The cumulative effects on water quality in the BSAI due to suspended solids are therefore considered insignificant.)

Table 4.9-15 Cumulative effects analysis for physical environment in vicinity of crab processors under all EIS alternatives
(Significance Ratings: S- (significant adverse), I (insignificant), and U (unknown))

Direct/indirect effects of proposed action	Significance of direct/ indirect effect	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Subsistence and sport fisheries	**Federal and State groundfish fisheries**	**State salmon and herring fisheries**	**Regulatory oversight**	**Flushing of receiving waters by tidal or wind-driven currents**	
Accumulation of benthic waste piles	I	Shore-based fish and crab processors with discharge into protected waters. Floating processors operating in protected waters with poor flushing currents. Clean Water Act.	<u>Potential adverse contribution-</u> small volumes of waste with some localized concentrations of waste disposal.	<u>Potential adverse contribution-</u> shore-based and floating processing of fish with seasonally high volumes.	<u>Potential adverse contribution-</u> shore-based processing of fish with seasonally high volumes.	<u>Potential beneficial contribution-</u> Environmental Protection Agency and State Dept. Of Environmental Conservation oversight/monitoring permitting under Clean Water Act.	<u>Potential beneficial/adverse contribution-</u> flushing rates of receiving water can enhance or impede dispersal of waste piles. Relatively quiescent waters are susceptible to further deterioration by waste discharges.	**Insignificant** - proposed action would result in only minor localized effects on pgysical environment. Cumulative condition: past and future accumulations of slowly biodegradable material affect localized areas, especially those with poor flushing characteristics Further deterioration of substrate condition can be minimized through discharge permits and monitoring as required per Clean Water Act.

Table 4.9-15(Cont.) Cumulative effects analysis for physical environment in vicinity of crab processors under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/ indirect effect	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Subsistence and sport fisheries	**Federal and State groundfish fisheries**	**State salmon and herring fisheries**	**Regulatory oversight**	**Flushing of receiving waters by tidal or wind-driven currents**	
Biological Oxygen Demand (BOD)	**I**	Shore-based fish and crab processors with discharge into protected waters. Floating processors operating in protected waters with poor flushing currents. Clean Water Act.	Potential adverse contribution- small volumes of waste with some localized concentrations of BOD.	Potential adverse contribution- shore-based and floating processing of fish with seasonally high concentration of BOD.	Potential adverse contribution- shore-based processing of fish with seasonally high concentration of BOD.	Potential beneficial contribution- Environmental Protection Agency and State Dept. Of Environmental Conservation oversight/monitoring permitting under Clean Water Act.	Potential beneficial/adverse contribution- Flushing rates of receiving water can mitigate or exacerbate concentrations of BOD. Relatively quiescent waters are susceptible to further deterioration by waste discharges.	**Insignificant** - proposed action would result in only minor localized effects on physical environment. **Cumulative condition:** past and future concentrations of BOD can cause localized anaerobic conditions with hydrogen sulfide and methane gas production. Further deterioration of water quality can be minimized through discharge permits and monitoring as required per Clean Water Act.

Table 4.9-15(Cont.) Cumulative effects analysis for physical environment in vicinity of crab processors under all EIS alternatives

Direct/indirect effects of proposed action	Significance of direct/ indirect effect	Past actions with persistent effects	Reasonably foreseeable future external actions					Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled				Natural	
			Subsistence and sport fisheries	**Federal and State groundfish fisheries**	**State salmon and herring fisheries**	**Regulatory oversight**	**Flushing of receiving waters by tidal or wind-driven currents**	
Suspended Solids	**I**	Shore-based fish and crab processors with discharge into protected waters. Floating processors operating in protected waters with poor flushing currents. Clean water Act.	Potential adverse contribution- small volumes of waste with little grinding into smaller particles.	Potential adverse contribution- shore-based and floating processing of fish with seasonally high concentrations of suspended solids.	Potential adverse contribution- shore-based processing of fish with seasonally high concentrations of suspended solids.	Potential adverse contribution- Environmental Protection Agency and State Dept. Of Environmental Conservation oversight/monitoring/ permitting under Clean Water Act.	Potential beneficial/adverse contribution- flushing rates of receiving water can mitigate or exacerbate dispersion of suspended solids. Relatively quiescent waters are susceptible to further deterioration by waste discharges.	**Insignificant** - proposed action would result in only minor localized effects on physical environment. Cumulative condition: past and future discharges of wastes with high suspended solids can have adverse biological and aesthetic effects. Further deterioration of water quality can be minimized through discharge permits and monitoring as required per Clean Water Act.

4.9.7 Cumulative effects analysis for benthic species and habitat

In this analysis, benthic species in the BSAI, other than commercially targeted crab, are considered as a group and include: fish, sea stars, urchins, corals, sponges, anemones, macroalgae, molluscs, octopi, snails, other crab, bryozoans, hydroids, stalked ascidians, sea onions, and other sessile invertebrates. Many of the sessile organisms provide physical and functional habitat to many other species within the benthic community, including economically important crab and groundfish species. Benthic species also serve as an integral part of the overall marine food web. Individual species or groups of similar species will be discussed in detail as they pertain to particular concerns or potential effects. The baseline conditions for the benthic species and habitat types important to this EIS have been described, to the extent that they are known, in Sections 3.3.1 and 3.3.2 and are summarized in Section 3.5. The direct/indirect effects of the BSAI king and Tanner crab fisheries on these species and habitat types have been analyzed in Sections 4.2 and 4.3. The types of effects considered in this cumulative analysis, and the reasonably foreseeable future actions that are predicted, have been modeled after a similar analysis for EFH in the BSAI/GOA groundfish fisheries (NMFS 2003a). Groundfish fisheries play a major role in overall impacts to benthic habitat. The cumulative effects analysis for all alternative rationalization programs are summarized in Table 4.9-16.

Mortality

- ***Direct and indirect effects of the proposed action***. All alternative rationalization programs are predicted to have the same magnitude of effect on total mortality of benthic species through bycatch and unobserved mechanisms such as crushing by gear or ghost fishing. Although no estimates of overall mortality are available, based on low observed bycatch rates and the relatively small area affected by pot gear each year, mortality of all non-target benthic organisms is considered to be insignificant. Effects on long-lived coral and other sessile species, especially from the Aleutian Islands golden king crab fishery, may require long recovery times. However, based on the limited presence of crab fishing in rocky substrate, impacts on these species are also considered insignificant.

- ***Past actions with persistent effects.*** Bycatch and other unobserved mortality of benthic organisms are associated with numerous past foreign, JV, and domestic trawl, dredge, longline, and pot gear fisheries as well as dredging for ports. Benthic organisms in some areas have also been smothered by accumulations of fish processing waste piles. The extent and intensity of past fishing activities on particular benthic species and persistence of past effects is unknown. The role of environmental contamination and persistence of pollutants in changes to abundance of these organisms has not been studied, and chronic effects associated with pollution are unknown.

- ***Reasonably foreseeable future external actions.*** Bycatch of benthic organisms in federal and state trawl, longline, and pot gear groundfish fisheries is expected to continue at relatively low rates. However, unobserved mortality through physical disruption of substrates by trawling and other bottom-contact gear may be substantial. Based on the small number of vessels participating in the Alaska scallop and shrimp fisheries, their contributions to overall mortality of benthic organisms in the future is most likely minimal. Offal discharge from offshore and onshore processors will continue to be regulated by local, state, and federal agencies, but is likely to result in future mortality of benthic organisms. Chronic environmental pollution and contamination from multiple sources is likely to persist throughout this region. An acute pollution event such as an oil spill could directly or indirectly impact benthic populations via numerous exposure pathways. Climatic variability is not expected to result in direct mortality of benthic organisms but may affect reproductive success and physiological health, thereby resulting in population-level changes.

- ***Cumulative effect.*** Continued mortality of benthic organisms through bycatch and habitat disruption by numerous fisheries may contribute to population-level effects for some species. Of particular concern are long-lived species, such as gorgonian corals and sponges, due to their inability to recover after damage and their susceptibility to permanent eradication in fished areas. Bottom trawling likely contributes much more to the mortality of benthic species than any other gear type due to its large bottom contact area and extensive use in the BSAI groundfish fisheries. The incremental contribution of the crab fisheries to the overall cumulative effect status is insignificant given their relatively small footprint in the overall BSAI region. However, the lack of baseline information on the abundance and distribution of most BSAI benthic species, combined with limited information on the particular impacts associated with different gear types, results in additional uncertainty when defining a cumulative condition for benthic species.

Changes in species diversity within the benthic community

- ***Direct and indirect effects of the proposed action.*** The crab fisheries remove target and non-target species from benthic communities and cause physical disturbance to the ocean bottom. Although baseline information on the abundance of non-target benthic species is very limited, bycatch levels of particular species in the crab fisheries are believed to be minimal relative to overall species diversity. The effects of the crab fisheries on benthic communities through removal of crab or other taxa, compared to their presumed abundance, are considered insignificant. This conclusion applies to all alternative rationalization programs.

- ***Past actions with persistent effects.*** Although the different types of benthic communities have not been mapped or documented in most areas of the BSAI, recent studies indicate that trawling and other bottom contact fishing gear disturbance can reduce habitat complexity and productivity (NRC 2002). For this reason, it is assumed that past foreign, JV, and domestic non-pelagic fisheries, especially groundfish bottom trawl fisheries, may exert persistent effects on benthic community dynamics and species distribution in the BSAI. In shallow waters, past dredging activities associated with port and harbor operation as well as discharge of fish and crab processing wastes likely resulted in persistent effects on local areas. Other potentially persistent effects include toxic contamination from accidents and discharges involving marine vessels, communities, military installations, changes in water quality from fish processing, changes in predator-prey relationships (i.e. decreases in sea otter populations leading to increases in urchin populations which lead to overgrazing and loss of kelp beds), and changes resulting from climatic and oceanographic fluctuations. Removal or depletion of vulnerable species within benthic communities may have occurred, but population-level baseline information is unavailable.

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue in the future. Climatic and oceanographic variability may result in adverse or beneficial effects to benthic organisms since some species thrive under certain conditions while others may suffer or resist change entirely.

- ***Cumulative effect.*** Some changes in species diversity have been noted in areas of high disturbance when compared to adjacent undisturbed areas. A direct association between fishing intensity and resulting magnitude of change in diversity has not been determined. No baseline condition is currently established for species diversity within benthic communities in the BSAI. However, fishing effects on some long-lived species and stable deep-water communities, especially those on rocky substrates in the Aleutian Islands, may be very slow to recover from disturbance, resulting in effects accumulating over time. The question of overall cumulative significance depends on the proportion of communities disturbed relative to their natural abundance in the BSAI. With very limited baseline information available on the structure, dynamics, and spatial distribution of benthic communities in the BSAI, the cumulative condition for species diversity within benthic communities cannot be determined.

<u>Changes in habitat</u>

- ***Direct and indirect effects of the proposed action.*** Crab and many other organisms use high-relief habitat as protective refuges during part or all of their life cycles. Such habitat includes non-living substrate such as boulders and cobble, but also includes living substrates such as corals, sponges, anemones, macroalgae, bryozoans, stalked ascidians, sea onions, and others (Sundberg and Clausen 1977). For many crab and fish species that migrate, it is important to have high-relief habitats in both shallow and deep waters. Such habitats may have very different structural compositions depending on water depth, sea temperature, currents, and geologic substrates. Since many deep water areas are characterized as stable environments dominated by long-lived species such as corals, the impacts of mechanical disruption from fishing gear can be substantial and long-term (Auster and Langton 1999). Concerns for damage to living habitat focus more on the Aleutian Islands, an area with known concentrations of tree corals and other species susceptible to mechanical damage. In contrast, the crab fishing grounds in the Bering Sea are characterized by a higher proportion of sandy or muddy low-relief habitat. Based on the relatively small areas that are impacted by pot gear in the Aleutian Islands golden king, red king, and Tanner crab fisheries, and considering that living habitats extend both inshore and seaward of the fishery impact zone, the BSAI king and Tanner crab fisheries are considered to have insignificant effects on living habitat. This conclusion applies to all alternative rationalization programs.

- ***Past actions with persistent effects.*** Living-habitat often consists of very slow-growing species and mortality or injury resulting from bottom-contact fishing gear which could have effects that extend for decades. Although the extent of historical damage has not been mapped or documented in many of the fishing grounds of the BSAI, it is assumed that all past foreign, JV, and domestic fisheries that used trawl, pot, longline, or dredging gear have had persistent effects on living habitat. In shallow waters, past dredging activities associated with port and harbor operation as well as discharge of fish and crab processing wastes are likely to have persistent past effects on living habitat as well. Other potentially persistent effects include toxic contamination from accidents and discharges involving marine vessels, communities, military installations, changes in predator-prey relationships (i.e. decreases in sea otter populations leading to increases in urchin populations which lead to overgrazing and loss of kelp beds), and changes resulting from climatic and oceanographic fluctuations.

- ***Reasonably foreseeable future external actions.*** All past actions listed above are likely to continue in the future.

- ***Cumulative effect.*** There are many questions regarding the determination of significance for effects on such dynamic entities as marine communities or the role that humans play in contributing to observed changes relative to natural fluctuations. In the present analysis, significance is related to the temporal longevity and spatial extent of the effect. Although bottom trawling, as well as pot and longline fishing, have occurred almost everywhere in the BSAI, the effects on the benthos are believed to be temporary, and therefore insignificant, for most areas with sandy/silty substrates. Long-lived corals and sponges have life history traits that make them susceptible to long-term and cumulative effects from fishery-induced mortality and injury. Other species that comprise living habitat may recover from disruption more quickly, but not necessarily in areas where fishing impacts are recurrent. Although current baseline conditions in many areas are unknown, the effects of repeated disturbance from different fisheries and other factors are considered to be cumulative and likely resulting in population-level effects on living habitat species over time. This is particularly likely in areas such as the Aleutian Islands.

Table 4.9-16 Cumulative effects analysis for benthic species* and habitat for all EIS alternatives

Direct/indirect effects of proposed action	Significance of Direct/Indirect Effect	Past actions with persistent effects	Reasonably foreseeable future external actions						Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled					Natural	
			Federal & State groundfish fisheries	**Scallop, shrimp, & other fisheries**	**Port expansion and dredging**	**Offal discharge**	**Pollution and environmental contamination**	**Climatic variability and regime shift**	
Mortality	**Insignificant**	Foreign, JV, and domestic trawl and pot gear fisheries; scallop dredging; smothering from fishery waste piles.	Potential adverse contribution - bycatch and unobserved mortality through trawling and other bottom gear.	Potential adverse contribution - bycatch and unobserved mortality through dredging and other bottom contact gear.	Potential adverse contribution - mortality from dredging of existing and future BSAI ports.	Potential adverse contribution - smothering and reduced BOD particularly inshore.	Potential adverse contribution - acute and/or chronic pollution could directly or indirectly affect mortality in benthic populations. Contamination of essential habitat.	Not a contributing factor - climatic variation and regime shift is not expected to result in direct mortality.	**Insignificant-** mortality from crab fisheries is likely minor. Cumulative condition: baseline information on population abundance, distribution, and trends of BSAI benthic organisms is not available for most areas or species.
Changes in species diversity within benthic community	**Insignificant**	Disruption and removal by bottom-contact fishing gear; natural disturbances.	Potential adverse contribution - disruption of living and non-living community elements through trawling and other bottom contact gear. Long-lived species particularly vulnerable to repetitive impacts.	Potential adverse contribution - disruption of living and non-living community elements from dredging and other bottom contact gear.	Potential adverse contribution - disruption of living and non-living community elements from dredging.	Potential adverse contribution - changes in species compositions in local areas due to waste accumulation, BOD concentration, and suspended solids.	Potential adverse contribution - mortality of vulnerable or sensitive species resulting from acute/chronic contamination may lead to changes in community structure.	Potential adverse or beneficial contribution - some species may thrive under certain conditions while others may suffer or resist change entirely.	**Insignificant-** bycatch levels of particular species in crab fisheries are presumed to be minor compared to overall species diversity. Cumulative condition: no baseline condition is currently established for species diversity within benthic communities of the BSAI.

Table 4.9-16(Cont.) Cumulative effects analysis for benthic species* and habitat for all EIS alternatives

Direct/indirect effects of proposed action	Significance of Direct/Indirect Effect	Past actions with persistent effects	Reasonably foreseeable future external actions						Cumulative effect (Significance of incremental contribution of proposed action and description of cumulative condition)
			Human-Controlled					Natural	
			Federal & State groundfish fisheries	**Scallop, shrimp, & other fisheries**	**Port expansion and dredging**	**Offal discharge**	**Pollution and environmental contamination**	**Climatic variability and regime shift**	
Changes in habitat	**Insignificant**	Foreign and domestic trawl, dredge, longline, and pot gear fisheries; port dredging; fishery waste accumulation and BOD; environmental contamination.	Potential adverse contribution - mortality and injury from bycatch and mechanical damage due to trawling, longline, and pot gear.	Potential adverse contribution - mortality and injury from bycatch and mechanical damage due to dredging and other bottom contact gear.	Potential adverse contribution - damage from dredging of existing and future BSAI ports.	Potential adverse contribution - smothering and reduced oxygen from BOD overload, particularly inshore.	Potential adverse contribution - acute and/or chronic pollution could directly or indirectly affect mortality in benthic populations.	Potential adverse or beneficial contribution - some species may thrive under certain climatic and oceanic conditions while others may decrease or remain stable.	**Insignificant-** contribution of crab fisheries is minimal compared to trawl fisheries. Cumulative condition: current baseline conditions in many areas of BSAI are unknown ; effects of repeated disturbance from different fisheries and other actions are likely resulting in population-level effects on living habitat species over time.

* Includes fish, gastropods, echinoderms, other crab, octopus, sponges, corals, and other invertebrates

4.9.8 Cumulative effects analysis for economics and socio-economics

The potential effects and implications are presented for six economic and socioeconomic characteristics:

- effects on the Harvesting Sector,
- effects on the Processing Sector,
- effects on Regions and Communities,
- effects on CDQ Groups,
- effects on Consumers and Environmental Benefits, and
- Environmental Justice Implications.

Table 4.9-17 presents the potential economic and socioeconomic cumulative effects for the four BSAI crab alternative rationalization programs. The tables summarize persistent past effects, external events and actions applicable to the potential cumulative effects, and potential significance of cumulative effects. Refer to Section 3.5.3.7 for a discussion of past/present external events and comparative baseline associated with the fishing industry, and regions and communities participating in the crab fisheries.

The indicators used to assess potential cumulative effects for each of the six characteristics listed above are the same used in the assessment of direct/indirect effects of the alternative rationalization programs. These indicators and the potential direct/indirect impacts are summarized in Sections 4.6 and 4.7 of the document. Indicators for effects on the harvesting and processing sectors were selected to evaluate potential consequences of management alternatives on specific aspects of the crab fisheries industry, and whether proposed management measures will have their intended effect: efficiency, capitalization, distribution of benefits between sectors, entry into the fisheries, and acquisition of excessive shares.

For industry participants that harvest or process only crab[1], external effects are minimal and tend to affect all participants equally (i.e. cost of fuel, insurance); therefore the cumulative effects for these participants are generally the same as the direct/indirect effects. However, for harvesters and processors that participate in other fisheries, trends and developments in these other fisheries can have an interactive effect on efficiency, capitalization, distribution of benefits, entry into the fisheries, and acquisition of shares. As with the assessment of direct/indirect effects (see Section 4.6), the cumulative economic effects of the alternative rationalization programs cannot be quantified. The cumulative effects analysis attempts to qualitatively assess effects on these indicators.

For communities and regions, the direct/indirect effect analysis evaluates regional and community level effects of the alternatives, including changes in harvesting and processing activity, employment and income, economic support services, and municipal revenue. Communities and regions are affected by changes in other fisheries, and by other economic and revenue trends. External effects from other fisheries interact with all five community and regional indicators, whereas trends in other economic activities and revenue source primarily affect the last three indicators.

[1] Harvesters and processors that depend exclusively or almost exclusively on crab are considered to participate only in the crab fisheries for purposes of this discussion.

4.9.8.1 Effects on the harvesting and processing sectors

Several of the harvesters that participate in crab fisheries also participate in other fisheries, such as groundfish, as harvesters and herring and salmon as tenders. Likewise, many of the processors that participate in crab fisheries also participate in other fisheries such as groundfish, salmon, halibut, and herring. In conjunction with the direct/indirect effects of crab alternative rationalization programs, trends in these fisheries could have an interactive and synergistic effect on harvesters and processors who participate in multiple fisheries. These other fisheries are the primary external factors that are relevant to the cumulative effects analysis, and the following discussion focuses on these effects.

Other external effects with potential for cumulative effects include factors that affect operating costs (e.g. fuel and insurance), competition/market substitution from other sources of crab, and future regulatory actions. These latter factors are difficult to predict and are likely to have the same effects for all alternative rationalization programs, and therefore are not included in the cumulative effects analysis.

Direct and indirect effects of the proposed action

Direct/indirect effects of proposed alternatives on the harvesting sector include the following:

- harvester efficiency,
- processing efficiency,
- harvester capitalization,
- processing capitalization,
- distribution of benefits between harvesters and processors,
- the ability of harvesters to enter the crab fisheries,
- the ability of processors to enter the crab fisheries, and
- acquisition of excessive shares in the fisheries.

Under the status quo, efficiency and capitalization remain at current levels, where efficiency is sacrificed in the race for fish and both the harvesting and processing sectors are over capitalized. Entry to the harvest sector is limited by the LLP, and potentially requires purchase of vessel and gear in addition to the LLP license. Entry to the processing sector is not directly limited, but facilities and expertise are required. Neither harvest shares nor processing shares are currently allocated under status quo. The three alternative rationalization programs improve efficiency and address overcapitalization by ending the race for fish, although regional and community landing requirements under two of the rationalization alternatives may offset some potential efficiency and capitalization gains. The allocation of harvest shares under all three programs will generally provide market power to harvesters. The processor landing requirements under the three-pie and cooperative alternatives offset this market power to some degree. In the three-pie alternative, harvester/processor interests are balanced by the arbitration program and its standard. In the cooperative program, harvester/processor market power is defined in part by the penalties for moving between cooperatives. In both of these programs, the presence of harvest shares that are not subject to processor delivery requirements will also affect the relative market power of the two sectors. All three rationalization alternatives allow some harvester entry to the fisheries through share purchases without excessive initial capital outlay, although alternatives with cooperatives could foster liberal leasing among current participants and limit the market for entrants to purchase interests in the fisheries. Processor entry to the fisheries is limited under the three-pie alternative by the allocation of processing shares and under the cooperative alternative by processor licenses and cooperative associations and landing requirements. Both programs, however, provide harvesters with some shares that may be delivered to processors that do not hold shares or program licenses, which could provide some entry opportunity. All three rationalization alternatives have caps that limit excessive harvesting shares. Processor share allocations are made only under the three-pie alternative, so limits on excessive processing shares are imposed only under that alternative. Limits on the number of licenses that a processor may hold are established under the cooperative program. Details on potential direct/indirect effects associated with each of the alternatives are presented in Sections 4.6.1 through 4.6.4.

Past actions with persistent effects

There are several persistent past effects that influence the analysis of cumulative effects and include events and management actions that have affected the crab fisheries, and events and management actions where there is a relationship between harvest sector participants that take part in both crab and other fisheries. The primary past effects include:

- management actions in the crab and other fisheries, including fishery closures, the vessel moratorium, and the establishment of the LLP,
- capitalization in response to the race for fish has lead to the development of excess capacity in the crab harvesting and processing sectors,
- creation of CDQs,
- vessel and processing sideboards established by the AFA, and
- the recent trends in other fisheries, such as the downturn in the salmon fishery and conservation (such as Steller sea lion habitat) related measures in groundfish fisheries.

For more detail on past effects and the comparative baseline, see Section 3.5.3.7.

Reasonably foreseeable future external actions

There are five categories of reasonably foreseeable future actions and events that influence potential cumulative effects on the harvesting sector. They include the following:

<u>Other state and federal commercial fisheries.</u> Many participants in the crab fisheries participate in multiple fisheries. The relative reliance of participants on these fisheries varies on a regional basis and on the status of the individual stocks. Trends in fisheries management (limits to entry, rationalization, and closures) and the economic conditions of the fisheries themselves are the main contributors to potential cumulative effects. In particular, AFA pollock fishery participants are likely to be advantaged by the stability of that fishery. Competition from farmed salmon and the decline in price for Alaskan salmon have adversely affected vessels that tender and processors that participate in both the salmon and crab fisheries. Conservation-related closures in federal groundfish fisheries have adversely affected vessels that participate in both the crab and groundfish fisheries. The continuation of these conditions is reasonably foreseeable.

<u>Other economic development activities.</u> Economic development, particularly the development or improvement of public infrastructure (primarily transportation projects), affects the viability and cost of doing

business in a community for participants. Funding for harbor and infrastructure improvements could become more difficult for communities to obtain if current economic conditions and federal and state budgets continue. Factors important to fish processors include the ability to move a processing work force in and out of a community, and marine infrastructure that may be important to landing catch and transhipping harvest.

Other tax revenue generated. Fish landed and processed, and property tax on processing facilities are a primary source of revenue for many fishing communities, which translates into facilities and public services important to fishing industry operations. Revenues from other fisheries and other sources such as revenue sharing are declining in many communities, and can affect the continued existence of these facilities and services. In some areas, reductions in non-fishing revenue sources may put more tax pressure on participants.

Natural fluctuations in crab stocks. Fluctuations in crab stocks drive fishery openings and closures, and establishment of GHLs or TACs. The extent of participation in crab fisheries may be based on these natural fluctuations, and resulting openings and GHLs or TACs.

Vessel Buyback. The Consolidated Appropriations Act of 2001 (P. L. No. 106-554), established a license and vessel buyback program in order to reduce fishing capacity in the BSAI crab fisheries. The statute authorized $100 million for the buyback program, which would come from an industry-financed loan. It is not possible to project the impacts of the buyback program quantitatively. Participation in the program is voluntary but must be approved by a two-thirds majority of the LLP holders who cast ballots on program approval. Under status quo, it is assumed that the buyback will remove vessels and LLP licenses from the fishery, but the number of actual vessels removed cannot be predicted, and the effects are uncertain. For the alternatives that rationalize the crab fisheries, the buyback will retire catch history as well as the vessels, thus reducing the number of licenses that generate quota share issuance. However, there is enough uncertainty regarding how and when the program will be implemented, and how much capacity would actually be removed from the fishery that foreseeable effects cannot be reasonably predicted and applied to the alternatives. Depending on the vessels and catch retired under buyback, specific processors could lose some opportunity to access crab. In addition, the buyback program only applies to catch history, not processing history. Potential effects are likely to be different on shore-based processors than C/P. The magnitude of the impact cannot be determined until the amount of history being bought back is determined, and the potential effects on processors under the rationalization cannot be reasonably foreseen at this time. See Appendix 1, Section 3.12 for more details.

Cumulative Effect

Potential effects of the status quo and rationalization program alternatives on cumulative conditions, and the significance of their incremental contribution to cumulative effects on harvesting and processing are summarized in detail in Table 4.9-17.

Alternative 1 Status Quo: The incremental contribution of the status quo alternative to cumulative conditions is insignificant. Under the race for fish, harvesters that currently participate only in crab fisheries are likely to experience insignificant changes in cumulative conditions with regard to efficiency, capitalization, and distribution of benefits. Holders of LLP licenses decide whether or not they want to participate in the race for fish. Harvest shares are not assigned. Other external factors are not substantial enough to change the significance of the direct/indirect effects assessment. For crab harvesters that participate in multiple fisheries, inefficiencies, excess capacity, and limits on entry opportunities in other fisheries may contribute to adverse cumulative conditions in terms of inefficiency and excess capacity. Entry opportunities are limited by the LLP and current overcapacity of the crab fisheries. Continuation of the status quo, however, will compound inefficiencies in other fisheries that are not rationalized through interactive effects of the race for fish in those other fisheries.

Alternative 2 Three-pie voluntary cooperative, Alternative 3 IFQ, and Alternative 4 Cooperatives: The incremental contribution of the three alternative rationalization program alternatives to cumulative conditions in many categories is significant beneficial. Under the program alternatives that rationalize the crab fisheries, harvesters that currently participate only in crab fisheries are likely to experience significant beneficial changes to cumulative conditions with regard to increases in efficiency, reduction in overcapitalization, and ease of entry into the fishery (see Section 4.6.4). These benefits may be offset to some extent by requirements related to regional and community landings.

Harvesters and processors that also participate in other fisheries may be able to use the predictability created by crab fishery rationalization to improve their participation in other fisheries. However, while crab rationalization may make a beneficial contribution to overall fishing and processing operations, conditions in other fisheries, including downturns (e.g. salmon), inefficiencies, excess capacity, and limits on entry opportunities may reduce the ability of participants to realize cumulative benefits through interaction with these other fisheries.

4.9.8.2 Effects on regions and communities

Communities benefit from the crab fishery through three major factors: employment (and associated income) generated by harvesting and processing, other economic activity that supports the crab fishery, and municipal revenue generated through local and state taxes and port facility user fees. Locally owned, locally based or serviced harvest vessels and shore-based processors are the major factor in generating local employment, economic activity, and revenue. The primary external factors that affect cumulative regional and community effects include other fisheries (groundfish, salmon, halibut, and herring), other economic development activities (such as infrastructure development, other government spending and programs including the military, and tourism), and trends in other sources of revenue (revenue sharing and state fiscal policy, private infrastructure development).

Direct and indirect effects of the proposed action

Direct/indirect effects of proposed alternatives on communities include the following:

- regional and community-based or serviced harvesters,
- regional and community-based processors,
- community employment and income,
- community economic support services, and
- municipal revenue.

The primary variations between alternatives include allocation of harvest shares and reductions in vessels in the harvesting sector, allocation of processing shares and processing landing requirements of cooperatives, requirements for regional and community landings/processing, and the potential for consolidation in the processing sector. Details on potential direct/indirect effects associated with each of the alternatives are presented in Sections 4.6.5 and Appendix 3.

Under the status quo, efficiency is sacrificed in the race for fish. Both the harvesting and processing sectors are overcapitalized. This results in short bursts of economic activity in communities with significant variation year to year. This situation is neither static nor stable, and adverse community and social effects would continue to occur on a fluctuating or inconsistent basis.

The rationalization alternatives (Alternatives 2, 3, and 4) will have complex community-level harvesting effects that depend on the species fished, and community base for harvesters (see Tables 4.6.14-16). Where communities harvest or process a relative small percentage of fish in total, a small shift in patterns of activity or the overall distribution of level of effort associated with share allocations may make a relatively large difference in total harvesting and processing by community interests. Community and social impacts will be further influenced by harvester share consolidation after the initial allocation (see Section 4.6.5.1). Fleet consolidation will result in a decrease in the number of crew positions. The nature of crew compensation may also change as the uncertainty of harvest success is reduced, however, remaining positions should be more stable. Community protection is addressed directly through regional and community landing requirements, and indirectly through processor share and cooperative landing requirements, but the alternatives vary substantially in the nature and degree of protections offered. All rationalization alternatives will spread out the fishing season, which will likely reduce the total direct/indirect community employment. Peak demand for services will also decline, due to fewer entities actively involved in the harvest sector and/or the processing sector, and the slowing down and spreading out of effort. In general, large multi-species processors will be able to adapt to longer seasons more readily than small crab specialty processors particularly under alternatives with less direct processor protection.

Under Alternative 2, processor share allocations, by design, closely mirror conditions that existed during the qualification period. Due to changing conditions and the specific eligibility and qualification criteria (including the timing of the qualification period itself), not all processors that have processed crab would receive quota share. Those that do not qualify tend to be smaller processors with less continuous history of participation, which reduces community and social impacts. To the extent that community protection measures function as they are intended, community and social impacts associated with processor consolidation following initial allocation are diminished under Alternative 2 (as discussed in Section 4.6.5 and Appendix 3). Processor consolidation, with associated community and social impacts linked to potential declines in employment, support sector activity, and municipal revenues, are more likely under Alternatives 3 and 4 with their lesser community protection provisions. Even under conditions of significant processor consolidation, however, not all engaged communities would experience adverse impacts as some communities would necessarily experience an increase in local activity if others decline.

Past actions with persistent effects

Persistent past effects that influence effects include events and management actions that have affected the crab fisheries, and events and management actions where there is a multi-species relationship between participants in crab and other fisheries. The primary past effects include:

- changes in economic conditions in other fisheries and diversification into multiple fisheries (groundfish, halibut, herring, and salmon),
- changes in other economic activities (government activity, shipping, tourism),
- development of marine infrastructure and services that support the crab fleet,

- management actions in state and federal fisheries other than crab, and
- reductions in state and federal revenue sharing.

For more detail on past effects and the comparative baseline, see Section 3.5.3.7.

Reasonably foreseeable future external actions

There are four categories of reasonably foreseeable future actions and events that influence potential cumulative effects on regions and communities. They include the following:

Other state and federal commercial fisheries. Many communities support multiple fisheries, including salmon, herring, state groundfish, federal groundfish, and halibut. They provide employment, goods and services to these fisheries, and in turn rely on associated fish tax for a major source of municipal revenue. The relative reliance and mix of involvement of communities in these fisheries varies on a regional basis and on the status of the individual stocks. Communities that have historically relied on salmon have seen economic returns decline dramatically in recent years. Communities engaged in groundfish fisheries have also felt the impact of conservation related area closures in recent years, with some communities more directly affected than others.

Other economic development activities. The development or improvement of public infrastructure and trends in other economic sectors (such as military projects and growth in tourism) have a direct bearing on overall local employment and income, economic support services, and municipal revenue. Compared to the economic effect of fisheries, other activities may be short-term in nature (e.g. generating employment for the duration of construction) or of smaller scale (tourism). Trends in these other economic sectors may accentuate or offset the economic effects of changes in management of the crab fisheries, and will vary by community and region. Infrastructure construction supports fisheries that bring in long-term economic benefits.

Other tax revenue generated. Fish landed and processed, and property tax on processing facilities are a primary source of revenue for communities, and are crucial to providing public facilities and services to residents. The relative reliance of involvement of communities on these fisheries varies on a regional basis and on the status of the individual stocks. Communities that have historically relied on salmon for municipal tax revenue have seen that revenue and associated budget reserves decline dramatically. Similarly, some communities that have relied on groundfish related municipal tax revenues have experienced adverse impacts associated with conservation related area closures implemented in recent years.

Natural fluctuations in crab stocks. Fluctuations in crab stocks drive fishery opening and closures, and establishment of GHLs or TACs. Fishery opening and closures, and the GHLs or TACs that are established, drive fishing activity and related harvesting and processing activity occurring in individual communities.

Cumulative effect

Potential effects of the status quo and rationalization program alternatives on cumulative conditions, and the significance of their incremental contribution to cumulative effects are summarized in detail in Table 4.9-17. The significance of the incremental contribution to cumulative effects varies across regions, communities, and between alternatives.

Communities where harvesting and processing sectors that could experience reductions in participation in crab fisheries, particularly those that also participate in fisheries for other species where there are downturns and closures (e.g., salmon, GOA groundfish), could experience adverse cumulative conditions. As noted in Section 4.6.5 and Appendix 3, there are large differences between participating communities in terms of the nature of their engagement with the relevant crab fisheries as well as level of dependency on these and other fisheries. On a general level, smaller communities with a less diversified economic base and a higher degree of dependency on the crab fishery in particular are more vulnerable to adverse cumulative effects than other communities. Community and regional landing/processing requirements will also affect harvesting and processing locational decisions with consequent impacts for communities that support multiple fisheries. Rationalization alternatives that eliminate these requirements will have significant adverse cumulative effects in the western Aleutians (Adak) and the Pribilof Islands (St. Paul and St. George). The Aleutians East Borough communities of King Cove and Sand Point would also be vulnerable to adverse cumulative impacts due to a number of interactive factors discussed in Appendix 3, including local dependence on a salmon fishery that is experiencing difficult conditions and multiple groundfish fishery challenges, among others.

<u>Alternative 1 Status Quo:</u> Under the race for fish, communities with residents that are currently engaged in and dependent upon the crab fisheries are likely to experience adverse cumulative effects. These include fluctuations in employment, economic support activities, and municipal revenue, which result from both the inefficiencies inherent in the race for fish and stock fluctuations that cause closures or substantial changes in harvest levels year to year. Trends in related economic activities and corresponding reductions in municipal revenue will aggravate adverse effects. For communities that support multiple fisheries, downturns (e.g. salmon) and inefficiencies, and excess capacity in other fisheries that are not rationalized, can result in adverse cumulative conditions. Associated community and social impacts would be seen in all of the participating Alaska regions, but again would vary based on both the overall size and structure of the local socioeconomic base as well as the particular nature and intensity of engagement in, and relative dependency on, the crab fisheries. Some communities, however, do benefit from the distribution of activity resulting from the race for fish. For example, in multi-landing seasons harvesters may choose to off load at a port closer to the fishing grounds to avoid the loss of time required to off load at a more distant, but generally preferred port. Similarly, additional support services are likely provided in relatively close proximity to the fisheries, since fishing is constrained to a relatively short season, leaving little time to acquire support services from more distant locations on short notice.

<u>Alternative 2 Three-pie voluntary cooperative, Alternative 3 IFQ, and Alternative 4 Cooperatives:</u> Under the program alternatives that rationalize the crab fisheries, the number of vessels qualifying for quota allocation in the crab fishery would be somewhat less than the number of vessels that have engaged in the fishery in recent years. Those vessels that would not qualify are generally more marginal vessels with a less consistent history of participation and/or vessels that have participated in the fishery only outside of the qualifying years. More of these vessels are Alaska based than Pacific Northwest based. While there would be at least some adverse community and social effects on employment, support activities, and revenue in some communities, the level of activity generated by these vessels is relatively small, and the associated impacts are unlikely to be significant. Slight increases in relative harvester QS over recent activity would proportionately accrue to Pacific Northwest communities, but would not be significant on the community level. Community level effects from changes in the processing sector vary widely by alternative. In general, there would be some consolidation, resulting in adverse community and social effects on employment, support activities, and revenue in some communities. However, the extent of consolidation would be influenced by regional and community landing requirements and protections and the evolution of cooperative activity. Alternative 2 would likely result in relatively little consolidation due to specific community protection measures. All things

being equal, multi-species processing plants would have more flexibility in responding to changes brought on by rationalization alternatives (see Section 4.6.5.3).

With regard to external events and cumulative effects, the collapse of salmon prices and area closures in the GOA groundfish fishery will adversely affect communities that support crab and other fisheries. Similarly, these regions are susceptible to declines in public spending, other economic activities, and sources of municipal revenue, resulting in adverse community and social cumulative effects.

4.9.8.3 Effects on CDQ groups

CDQ groups participate in commercial groundfish and halibut fisheries in addition to crab; in each case specific CDQ groups have specific QS for each fishery. Participation generates employment opportunities for western Alaskans, and revenue for fishery-related economic development in CDQ group communities.

With the exception of status quo, the CDQ QS of crab increases under each rationalization alternative. QS for other fisheries will remain constant under every alternative, although actual harvest levels will vary based on stock status.

Direct and indirect effects of the proposed action

Direct/indirect effects of proposed alternatives on CDQ groups include the following: harvesting efficiency, processing efficiency, and ability to enter additional fisheries. Details on potential direct/indirect effects associated with each of the alternatives are presented in Sections 4.6.5 and Appendix 3.

Past actions with persistent effects

Persistent past effects for CDQ groups are different from other industry participants. Because QS is currently allocated to CDQ groups, the effects of rationalization are likely to be less pronounced. Stock levels and fishery closures have had and will continue to have the greatest effect on CDQ groups. The trend of increases in species and percent for which share has been allocated to CDQs has increased their involvement in multi-species fisheries.

Reasonably Foreseeable Future External Actions

There are two categories of reasonably foreseeable future actions and events that influence potential cumulative effects on regions and communities. They include the following:

<u>Other state and federal commercial fisheries.</u> Many harvesters and processors participate in multiple fisheries, including salmon, state groundfish, federal groundfish, herring, and halibut. The relative reliance of CDQ-owned harvesters and processors on these fisheries varies on a regional basis and on the status of the individual stocks. Trends in fisheries management (allocation, rationalization, and closures) and the economic conditions of the fisheries themselves are the main contributors to potential cumulative effects.

<u>Natural fluctuations in crab stocks.</u> Fluctuations in crab stocks drive fishery opening and closures, and establishment of GHLs or TACs. CDQ allocations depend on and will change with the TACs or GHLs.

Cumulative Effect

Potential effects of the status quo and rationalization program alternatives on cumulative conditions, and the significance of their incremental contribution to cumulative effects are summarized in detail in Table 4.9-17.

Alternative 1 Status Quo, Alternative 2 Three-pie voluntary cooperative, Alternative 3 IFQ, and Alternative 4 Cooperatives: The incremental contribution of the Status Quo Alternative (Alternative 1) to cumulative conditions regarding the CDQ program is insignificant. Given that CDQ QS increases by an additional 2.5 percent of the overall quota for all rationalization alternatives and increasing the crab species to include allocations of eastern Aleutian Islands golden king crab and western Aleutian Islands red king crab, cumulative effects are significant beneficial for Alternatives 2, 3, and 4. The efficiency of CDQ crab operations increase through a rationalized fishery, but this gain is proportionately smaller for CDQ groups than for other participants as the CDQ portion of the fishery was already rationalized. The ability of CDQ groups to gain more share of the fishery through purchase of harvest shares in the general fishery is enhanced, which is a beneficial impact. Adverse cumulative impacts could accrue to CDQ groups through ongoing participation in other more problematic fisheries, with the salmon fishery being a prime example. However, the relatively small CDQ participation in the salmon fishery, given CDQ diversification in other fisheries, is not enough to offset the gains that would be realized under rationalization of the crab fisheries. CDQ groups could also lose some market advantage since their current harvests are not subject to the same time constraints confronting participants in the current race for fish. These advantages appear to be quite small, so this loss is likely to be minimal.

4.9.8.4 Effects on consumers and environmental benefits

Direct and indirect effects of the proposed action

Under Alternative 1 Status Quo, the race for fish, handling of bycatch of undersized and female crab, and ghost fishing of lost pots could contribute to some mortality and affect quality. Processors engage in a similar race to quickly offload and process crab to gain market share and limit deadloss, affecting product quality and diversity.

Rationalization under Alternatives 2, 3, and 4 will improve both the quality and year round availability of crab product to the consumer. The environmental benefits of ending the race for fish include reduced handling mortality and dead loss, and reduced loss of gear and ghost fishing.

Past Actions with persistent effects

The primary actions with past effects are fishery management measures associated with protection of crab stocks and how crab fisheries are conducted, and the effects of other fisheries on crab stocks. They affect the supply and price of crab, and result in internal and external effects on the viability of crab populations.

Reasonably foreseeable future external actions

Reasonably foreseeable future external actions that contribute to environmental benefit cumulative effects are the same as those discussed in detail under Section 4.9.2. With regard to consumer benefits, future external actions are associated with other fisheries that may affect the availability of crab, other sources of crab, and substitutes for crab. No changes over current conditions are assumed to occur.

Cumulative effect

Alternative 1 Status Quo: The incremental contribution of the Alternative 1 to consumers and environmental benefits is driven by the direct/indirect effects of the race for fish.

Alternative 2 Three-pie voluntary cooperative, Alternative 3 IFQ, and Alternative 4 Cooperatives: The incremental contribution of the three rationalization alternatives to consumers and environmental benefits is driven by the direct/indirect effects of ending the race for fish.

4.9.8.5 Environmental justice implications

There are four special populations for which the BSAI crab fisheries management alternatives have Environmental Justice implications: non-CDQ Alaska Natives participating in the fisheries as harvesters, CDQ groups and communities that are predominantly Alaska Native, non-CDQ communities that support fisheries and have a significant Alaska Native component, and minority groups that participate in the fish processing industry.

Direct and indirect effects of the proposed action

Direct/indirect effects of proposed alternatives include crab community level impacts, CV/fleet-related impacts, C/P related impacts, shore processor related impacts, and CDQ group-related impacts. See Section 4.7 for additional detail.

Past actions with persistent effects

Persistent past effects for Environmental Justice are similar to those previously discussed under the harvesting sector, the processing sector, and regions and communities.

Reasonably foreseeable future external actions

There are four categories of reasonably foreseeable future actions and events that influence potential cumulative effects on harvesting/processing participants and communities that are subject to Environmental Justice considerations. They include the following:

Other state and federal commercial fisheries. Many industry sectors and communities participate or support multiple fisheries, including salmon, state groundfish, federal groundfish, herring, and halibut. The relative reliance and mix of involvement in these fisheries varies on a regional basis and on the status of the individual stocks. Fishing and communities, that have historically relied on salmon and fisheries subject to closures, have experienced adverse effects due to these external events and actions.

Other economic development activities. The development or improvement of public infrastructure and trends in other economic sectors (such as military projects and growth in tourism) have a direct bearing on overall local employment and income, economic support services, and municipal revenue in communities with special populations subject to Environmental Justice considerations. Compared to the economic effect of fisheries, other activities may be short-term in nature (e.g. generating employment for the duration of construction) or of smaller scale (tourism). Trends in these other economic sectors may accentuate or offset the economic effects of changes in management of the crab fisheries, and will vary by community and region. Infrastructure construction supports fisheries that bring in long-term economic benefits.

Other tax revenue generated. Fish landed and processed, and property tax on processing facilities are a primary source of revenue for communities with special populations that are subject to Environmental Justice considerations, and are crucial to providing public facilities and services to residents. The relative reliance of involvement of communities on these fisheries varies on a regional basis and on the status of the individual stocks. Communities that have historically relied on salmon for municipal tax revenue have seen that revenue and associated budget reserves decline dramatically.

Natural fluctuations in crab stocks. Fluctuations in crab stocks drive fishery openings and closures, and establish GHLs or TACs. Fishery openings and closures, and the GHLs or TACs that are established, drive fishing activity, and related harvesting and processing activity occurring in individual communities.

Cumulative effects

Potential effects of the status quo and rationalization program alternatives on cumulative conditions, and the significance of their incremental contribution to cumulative effects are summarized in detail in Table 4.9-17. The significance of the incremental contribution to cumulative effects varies across special populations subject to Environmental Justice considerations, and also varies between alternatives. Because the program rationalization alternatives change the distribution of harvesting and processing, impacts vary across populations.

Alternative 1 Status Quo: Under the status quo alternative, no potential high and adverse impacts to minority populations or low-income populations in BSAI crab communities specific to direct/indirect actions have been identified. Therefore, the incremental contribution of the proposed action is insignificant. In terms of cumulative conditions, fishing industry sectors and communities participating in fisheries affected by the downturn in the salmon industry and GOA groundfish fisheries habitat related closures have Environmental Justice implications. Similarly, Alaskan communities with substantial minority or low-income populations have experienced adverse effects resulting from reduction in sources of state and municipal revenue.

Alternative 2 Three-pie voluntary cooperative, Alternative 3 IFQ, and Alternative 4 Cooperatives: The incremental contribution of the three alternative rationalization program alternatives to cumulative conditions is generally beneficial or insignificant. The effect, however, could be adverse for some communities. Adverse effects of consolidation in processing could disproportionately impact communities with relatively large Alaska Native populations, possibly St. George and King Cove. If the community protection measures of the preferred alternative are effective, adverse impacts could be minimized or avoided. Any consolidation in processing is also likely to result in job losses for minority populations. Remaining jobs, however, could be more stable than those in the existing fisheries. These adverse effects could be compounded by external factors in areas which may have suffered from salmon declines or groundfish area closures. However, because the behavior of industry participants under each of the alternatives cannot be fully predicted, the distribution of effects cannot be predicted at this time.

Table 4.9-17 Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Harvester Efficiency (revenues minus costs)	**Direct/Indirect** - Insignificant **Cumulative** - Insignificant **Cumulative Condition:** harvesters that participate only in crab fisheries efficiency remains at current level. For participants that participate in multiple fisheries, limited entry opportunities in other fisheries can contribute to adverse cumulative effects on efficiency.	**Direct/Indirec**t - unknown (insignificant/significant beneficial) **Cumulative** - unknown (insignificant/significant beneficial) **Cumulative Condition:** harvester efficiency improves with allocation of harvest shares and end of the race for fish; however, efficiency could be reduced by processors share and regional landing requirements and community protections. Consolidation and efficiency gains could be accelerated, if buyback is completed prior to rationalization. Due to external influences, harvesters that participate in other fisheries may have cumulative efficiency increased by the ability to schedule participation in other fisheries more efficiently.	**Direct/Indirect** - Significant Beneficial **Cumulative** - Significant Beneficial **Cumulative Condition:** harvester efficiency improves with allocation of harvest shares and end of the race for fish, however efficiency could be reduced by regional landing requirements. Consolidation and efficiency gains could be accelerated, if buyback is completed prior to rationalization. Due to external influences, harvesters that participate in other fisheries may have cumulative efficiency increased by the ability to schedule participation in other fisheries more efficiently.	**Direct/Indirec**t - unknown (insignificant/significant beneficial) **Cumulative** - unknown (insignificant/significant beneficial) **Cumulative Condition:** harvester efficiency improves with allocation of harvest shares and end of the race for fish; however, efficiency may be reduced by cooperative processor landing requirements. Industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss. Consolidation and efficiency gains could be accelerated, if buyback is completed prior to rationalization. Due to external influences, harvesters that participate in other fisheries may have cumulative efficiency increased by the ability to schedule participation in other fisheries more efficiently.

Table 4.9-17(Cont.) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Processor Efficiency (revenues minus costs)	**Direct/Indirect** - Insignificant **Cumulative** - insignificant **Cumulative Condition**: under the race for fish, crab processor efficiency is reduced; combined with downturns and excess capacity in other fisheries such as salmon, there is cumulative excess processing capacity, which adversely effects efficiency.	**Direct/Indirec**t - unknown (insignificant/significant beneficial) **Cumulative** - unknown (insignificant/significant beneficial) **Cumulative Condition**: processor efficiency improves with end of the race for fish and allocation of processor shares; efficiency can be reduced by regional and community protection programs and regional delivery requirements. Processors that participate in other fisheries may have cumulative efficiency offset by current downturns in salmon, or increased by the ability to schedule participation more efficiently.	**Direct/Indirec**t - unknown (insignificant/significant beneficial) **Cumulative** - unknown (insignificant/significant beneficial/significant detrimental) **Cumulative Condition**: processor efficiency improves with the end of the race for fish; efficiency can be reduced by regional delivery requirements. Absence of processor protection could lead to detrimental effects during transitions. Processors that participate in other fisheries may have cumulative efficiency offset by current downturns in salmon, or increased by the ability to schedule participation more efficiently.	**Direct/Indirec**t - unknown (insignificant/significant beneficial) **Cumulative** - unknown (insignificant/significant beneficial) **Cumulative Condition**: processor efficiency improves with allocation of harvest shares through cooperatives and the end of the race of fish, efficiency may be increased or decreased by cooperative processor landing requirements. Processors that participate in other fisheries may have cumulative efficiency offset by current downturns in salmon, or increased by the ability to schedule participation more efficiently.
Harvester capitalization	**Direct/Indirect** - Insignificant **Cumulative** - insignificant **Cumulative Condition**: under the race for fish, harvester capitalization remains near current level with excess capacity; for vessels participating in other fisheries that are not rationalized excess capacity is increased in the near term.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition**: harvester capitalization is reduced by coordination of harvests between harvest share holders, season extensions, and relaxation of pot limits; however, community and regional landing requirements may offset some reductions in capitalization. Consolidation and efficiency gains could be accelerated, if buyback is completed prior to rationalization. Due to external influences, some excess capitalization may still exist for harvesters participating in fisheries that are not rationalized.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition**: harvester capitalization is reduced by coordination of harvests between harvest share holders, season extensions, and relaxation of pot limits; however, regional landing requirements may offset some reductions in capitalization. Consolidation and efficiency gains could be accelerated, if buyback is completed prior to rationalization. Due to external influences, some excess capitalization may still exist for harvesters participating in fisheries that are not rationalized.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition**: harvester capitalization is reduced by coordination of harvests by harvest share holders, season extensions, and relaxation of pot limits. Consolidation and efficiency gains could be accelerated, if buyback is completed prior to rationalization. Due to external factors, some excess capitalization may still exist for harvesters that participate in fisheries that are not rationalized.

Table 4.9-17(Cont.) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Processor capitalization	**Direct/Indirect** - Insignificant **Cumulative** - insignificant **Cumulative Condition**: under the race for fish, processor capitalization is geared for peak delivery levels, resulting in excess capacity. For processors participating in multiple fisheries, particularly salmon, excess capacity is increased. Processors that have excess capacity and are financially stressed may retain capital currently being used to maintain qualification for future rationalization.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition**: with shares assigned, processors should make capitalization decisions based on efficiency; gains may be reduced by regional landing requirements and community protections. Excess capacity may exist in plants that also process salmon, although the ability to process crab throughout more of the year may improve use of facilities.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition**: processor capitalization could be reduced by formation of cooperatives and ending the race for fish. Excess capacity may exist in processing plants that also process salmon, although the ability to process crab throughout the year may improve use of facilities.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition**: processor capitalization could be reduced by formation of coops and ending the race for fish. Excess capacity may exist in plants that also process salmon, although the ability to process crab throughout may improve year around use of facilities.
Production efficiency (harvesting and processing)	**Direct/Indirect** - Insignificant **Cumulative** - insignificant **Cumulative Condition**: crab fishery efficiency remains at current level. For participants that participate in multiple fisheries, entry opportunities and conditions in other fisheries can contribute to adverse cumulative effects on efficiency.	**Direct/Indirect** - Significant beneficial **Cumulative** - significant beneficial **Cumulative Condition**: production efficiency improves with an end to the race for fish. Coordination of crab participation and production decisions with activities in other fisheries improves cumulative production efficiency. Benefits increase with coordination with other rationalized fisheries.	**Direct/Indirect** - Significant beneficial **Cumulative** - significant beneficial **Cumulative Condition**: production efficiency improves with an end to the race for fish. Coordination of crab participation and production decisions with activities in other fisheries improves cumulative production efficiency. Benefits increase with coordination with other rationalized fisheries.	**Direct/Indirect** - Significant beneficial **Cumulative** - significant beneficial **Cumulative Condition**: production efficiency improves with an end to the race for fish. Coordination of crab participation and production decisions with activities in other fisheries improves cumulative production efficiency. Benefits increase with coordination with other rationalized fisheries.
Harvester entry	**Direct/Indirect** - Insignificant **Cumulative** - insignificant **Cumulative Condition**: under the current LLP, the crab fisheries appear to be fully capitalized and future entry is limited by costs associated with purchase of LLP license, vessel, and gear.	**Direct/Indirect** - Unknown **Cumulative** - unknown **Cumulative Condition**: gradual entry to the fishery could occur through acquisition of quota share, although cooperatives could inhibit entry. Entry could come from participants in other stable fisheries (such as Bering Sea pollock).	**Direct/Indirect** - Unknown **Cumulative** - unknown **Cumulative Condition**: gradual entry to the fishery could occur through acquisition of quota share. Entry could come from participants in other stable fisheries (such as Bering Sea pollock).	**Direct/Indirect** - Unknown **Cumulative** Unknown **Cumulative Condition**: gradual entry to the fishery could occur through acquisition of quota share, although cooperatives could inhibit entry. Entry could come from participants in other stable fisheries (such as Bering Sea pollock).

Table 4.9-17(Cont.) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Processor Entry	**Direct/Indirect** - Insignificant **Cumulative** - insignificant **Cumulative Condition**: the crab fisheries appear to be fully capitalized and entry is unlikely in the near future; entry could increase as stocks recover and harvests increase.	**Direct/Indirect** - unknown **Cumulative** - Unknown **Cumulative Condition**: entry opportunities are likely to be affected by processor activity in other fisheries. Processors in other rationalized fisheries are most likely able to purchase shares needed for entry.	**Direct/Indirect** - unknown **Cumulative** - Unknown **Cumulative Condition**: ability to enter may be affected by processor involvement in other fisheries.	**Direct/Indirect** - unknown **Cumulative** - Unknown **Cumulative Condition**: ability to enter is likely to be affected by participation in other fisheries.
Acquisition of excessive shares	**Direct/Indirect** - insignificant **Cumulative** - insignificant **Cumulative Condition**: shares are currently not allocated to either harvesters or processors under the LLP; therefore, excessive share limits are not applicable.	**Direct/Indirect** - insignificant **Cumulative** - insignificant **Cumulative Condition**: caps on share use apply to both sectors to prevent excessive consolidation.	**Direct/Indirect** - insignificant **Cumulative** - insignificant **Cumulative Condition**: caps on share use apply to the harvest sector. No shares are allocated in the processing sector.	**Direct/Indirect** - insignificant **Cumulative** - insignificant **Cumulative Condition**: caps on share use apply to the harvest sector. Limits on number of processing licenses are intended to limit consolidation in processing.
Community/social impact - harvesters	**Direct/Indirect** - Insignificant **Cumulative** - Insignificant **Cumulative Condition**: over-capitalization and the race for fish in the crab fishery will continue current regional participation trends. Conditions in groundfish fisheries could affect harvest vessels participating in crab and groundfish fisheries in an unpredictable manner.	**Direct/Indirect** - unknown - will vary depending on the region and community **Cumulative** - unknown - will vary depending on the region and community **Cumulative Condition**: qualifying years determine the quota allocations, which may favor some communities and regions over others. Changes in distribution from trading cannot be predicted. The collapse of salmon prices and conservation related area closures in groundfish fisheries could adversely affect harvest vessels that tender salmon or participate in groundfish fisheries.	**Direct/Indirect** - unknown - will vary depending on the region and community **Cumulative** - unknown - will vary depending on the region and community **Cumulative Condition**: qualifying years determine the quota allocations, which may favor some communities and regions over other years (see Table 4.6-14). Changes in distribution from trading cannot be predicted. The collapse of salmon prices and conservation related area closures in groundfish fisheries could adversely affect harvest vessels that tender salmon or participate in groundfish fisheries.	**Direct/Indirect** - unknown - will vary depending on the region and community **Cumulative** - unknown - will vary depending on the region and community **Cumulative Condition**: qualifying years determine the quota allocations, which may favor some communities and regions over other years (see Table 4.6-14). Changes in distribution from trading cannot be predicted. The collapse of salmon prices and conservation related area closures in groundfish fisheries could adversely affect harvest vessels that tender salmon or participate in groundfish fisheries.

Table 4.9-17(Cont.) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Community/social impact - processors	**Direct/Indirect** - unknown - will vary depending on the region and community **Cumulative** - unknown - will vary depending on the region and community **Cumulative Condition**: over-capitalization and the race for fish in the crab fishery will extend current regional participation trends. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect shore-based processors participating in crab and those other fisheries.	**Direct/Indirect** - unknown - will vary depending on the region and community **Cumulative** - unknown - will vary depending on the region and community **Cumulative Condition**: community impacts depend on shares processed in the community. Qualifying years determine the quota allocations, which may favor some communities and regions over others (see Table 4.6-14). Changes in distribution from trading cannot be predicted. Community protection measures may reduce or slow changes in distribution of crab processing. The collapse of salmon prices and conservation related area closures in groundfish fisheries could adversely affect processors that participate in the salmon and groundfish fisheries.	**Direct/Indirect** - unknown - will vary depending on the region and community **Cumulative** - unknown - will vary depending on the region and community **Cumulative Condition**: consolidation is expected although may be reduced by regional landing requirements; some communities could gain and others could lose processing. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect onshore plants participating in crab and those other fisheries.	**Direct/Indirect** - unknown - will vary depending on the region and community **Cumulative** - unknown - will vary depending on the region and community **Cumulative Condition**: cooperative affiliations will contribute to distribution of processing. Movement among cooperatives cannot be predicted. Some consolidation is expected to take place with no regional landing requirements. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect onshore plants participating in crab and those other fisheries.

Table 4.9-17(Cont.) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Community/social impact - employment and Income	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: over-capitalization and the race for fish in the crab fishery should extend current regional and community employment trends. Distribution of activity, however, could change with conditions in the crab fishery and other fisheries. The collapse of salmon prices and conservation related area closures in groundfish fisheries could adversely affect employment in communities that participate in or support crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization would generally stabilize employment although at levels less than current peak. Geographic distribution of activity will vary across regions and communities. Regional landing requirements and community protections would potentially result in more stability in processing employment. Fewer crew positions are likely to remain, but those that remain should be more stable; though crew shares could be affected. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect employment in communities that participate in crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization would generally stabilize employment although at levels less than current peak. Geographic distribution of activity will vary across regions and communities. Regional landing requirements would potentially result in more stability in processing employment. Fewer crew positions are likely to remain, but those that remain should be more stable; though crew shares could be affected. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect employment in communities that participate in crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization would generally stabilize employment although at levels less than current peak. Geographic distribution of activity will vary across regions and communities. Absence of regional landing requirements and community protections could result in less stability in processing employment. Fewer crew positions are likely to remain, but those that remain should be more stable; though crew shares could be affected. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect employment in communities that participate in crab and those other fisheries.

Table 4.9-17(Cont.) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Economic support services	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: over-capitalization and the race for fish in the crab fishery will extend current regional and community economic support service trends. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect support services in some communities that participate in or support crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization would "stabilize" demand for support services over the long-term, although at levels less than current peak. Some fleet and plant consolidation is expected to take place, which could be mitigated or slowed by processor shares, regional landing requirements and community protections would potentially result in more stability to demand for support services in some areas. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect support services in communities that participate in crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization would "stabilize" demand for support services over the long-term, although at levels less than current peak. Some fleet and plant consolidation is expected to take place, regional landing requirements would potentially result in more stability in some areas. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect support services in communities participating in crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization would "stabilize" demand for support services over the long-term, although at levels less than current peak. Some fleet and plant consolidation is expected to take place, which could be mitigated or slowed by cooperative associations. The collapse of salmon prices and conservation related area closures in groundfish fisheries will adversely affect support services in communities participating in crab and those other fisheries.

Table 4.9-17(Cont.) **Summary of Socio-economic, Community and Regional Cumulative Effects.**

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Municipal revenue	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: over-capitalization of the race for fish in the crab fishery will extend current municipal revenue trends; however, fluctuation in GHLs would affect revenues. The collapse of salmon prices and conservation related area closures in groundfish fisheries will continue to adversely affect municipal revenues in communities that participate in or support crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization with regional landing requirements and community protections will stabilize crab-related municipal revenue; although, consolidation could impact revenues in some communities and GHL fluctuations perpetuate uncertainty. Processing share allocations could slow consolidation. The reductions in federal/state revenue sharing, collapse of salmon prices, and conservation related area closures in groundfish fisheries will adversely affect municipal revenues in communities that participate in or support crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization with regional landing requirements will stabilize crab-related municipal revenue; although, plant consolidation could impact revenues in some communities and GHL fluctuations perpetuate uncertainty. The reductions in federal/state revenue sharing, collapse of salmon prices, and conservation related area closures in groundfish fisheries will adversely affect municipal revenues in communities that participate in or support crab and those other fisheries.	**Direct/Indirect** - Unknown - impact varies by region and community **Cumulative** - Unknown - impact varies by region and community **Cumulative Condition**: rationalization will stabilize crab-related municipal revenue; although, consolidation could impact revenues in some communities and GHL fluctuations perpetuate uncertainty. Cooperative associations could slow consolidation. The reductions in federal/state revenue sharing, collapse of salmon prices, and conservation related area closures in groundfish fisheries will adversely affect municipal revenues in communities that participate in or support crab and those other fisheries.

Table 4.9-17(Cont.) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
CDQ participation and benefits	**Direct/Indirect** - Insignificant **Cumulative** - insignificant **Cumulative Condition**- CDQ allocation is unchanged and the race for fish continues in the general fishery. CDQ groups may continue to increase participation in general fishery.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition** - increase in the CDQ allocation and increased stability of the crab fisheries from rationalization should support increased CDQ participation and benefits in the crab fisheries. Participation in the rationalized non-CDQ crab fisheries could be favored over participation in fisheries that are not rationalized. Participation in harvesting and processing could be affected by processor shares but effect is not predictable.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition** - increase in the CDQ allocation and increased stability of the crab fisheries from rationalization should support increased CDQ participation and benefits in both the CDQ and general fisheries. Participation in the rationalized non-CDQ crab fisheries could be favored over participation in fisheries that are not rationalized.	**Direct/Indirect** - Significant Beneficial **Cumulative** - significant beneficial **Cumulative Condition** - increase in the CDQ allocation and increased stability of the crab fisheries from rationalization should support increased CDQ participation and benefits in both the CDQ and general fisheries. Participation in the rationalized non-CDQ crab fisheries could be favored over participation in fisheries that are not rationalized. Effect of cooperative associations on participation in harvesting and processing is not predictable.

Table 4.9-17(Cont.) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Environmental justice - employment effects	**Direct/Indirect** - insignificant **Cumulative** - insignificant **Cumulative Condition**: over-capitalization and the race for fish in the crab fishery will extend current hiring practices in harvesting, processing, and communities.	**Direct/Indirect** - unknown **Cumulative** - unknown **Cumulative Condition** - slowing the race for fish will result in fewer jobs; however, those jobs will be for a longer part of the year and will be more stable but still subject to uncertainty with uncertainty in TACs. Rationalization will facilitate employment in multiple fisheries with overlapping seasons. Overall effect on minority populations cannot be predicted.	**Direct/Indirect** - unknown **Cumulative** - unknown **Cumulative Condition** - slowing the race for fish will result in fewer jobs; however, those jobs will be for a longer part of the year and will be more stable but still subject to uncertainty with uncertainty in TACs. Rationalization will facilitate employment in multiple fisheries with overlapping seasons. Overall effect on minority populations cannot be predicted.	**Direct/Indirect** - unknown **Cumulative** - unknown **Cumulative Condition** - slowing the race for fish will result in fewer jobs; however, those jobs will be for a longer part of the year and will be more stable but still subject to uncertainty with uncertainty in TACs. Rationalization will facilitate employment in multiple fisheries with overlapping seasons. Overall effect on minority populations cannot be predicted.
Environmental justice - communities impacts	**Direct/Indirect** - Insignificant **Cumulative** - insignficant **Cumulative Condition** - current trends of relatively short seasons will continue. Distribution of activity among communities will continue but will vary with GHLs.	**Direct/Indirect** - Unknown - **Cumulative** - unknown **Cumulative Condition** - slowing the race for fish with regional landing requirements and community protections should lead to more stable levels of activity in communities. Consolidation of activity will occur but cannot be predicted. Processor shares may slow consolidation.	**Direct/Indirect** - Unknown - **Cumulative** - unknown **Cumulative Condition** - slowing the race for fish with regional landing requirements should lead to more stable levels of activity in communities. Consolidation of activity will occur but cannot be predicted. It is likely that processing would decline in at least some Alaska Native communities with consolidation; additionally, processing employment losses would occur within a minority population labor pool.	**Direct/Indirect** - Unknown - **Cumulative** - unknown **Cumulative Condition** - slowing the race for fish should lead to more stable levels of activity in at least some communities. Consolidation of activity will occur but cannot be predicted. Cooperative associations may slow consolidation. It is likely that processing would decline in at least some Alaska Native communities with consolidation; additionally, processing employment losses would occur within a minority population labor pool.

Table 4.9-17 (Cont) Summary of Socio-economic, Community and Regional Cumulative Effects.

	Alternative 1 Status Quo	Alternative 2 Three-Pie	Alternative 3 IFQ	Alternative 4 Cooperative
Captains and crew	**Direct/Indirect** - Insignificant **Cumulative** - Insignificant **Cumulative Condition**: Race for fish continues with captains and crew working during short crab seasons. Some work in other fisheries to supplement crab income.	**Direct/Indirect** - Unknown **Cumulative** - Unknown **Cumulative Condition**: Seasons are extended with race for fish with crew remaining in the crab fisheries receiving more complete employment. Some crew are removed from crab fisheries with reduction in vessels. Some may attempt to move to or expand participation in other fisheries.	**Direct/Indirect** - Unknown **Cumulative** - Unknown **Cumulative Condition**: Seasons are extended with race for fish with crew remaining in the crab fisheries receiving more complete employment. Some crew are removed from crab fisheries with reduction in vessels. Some may attempt to move to or expand participation in other fisheries.	**Direct/Indirect** - Unknown **Cumulative** Unknown **Cumulative Condition**: Seasons are extended with race for fish with crew remaining in the crab fisheries receiving more complete employment. Some crew are removed from crab fisheries with reduction in vessels. Some may attempt to move to or expand participation in other fisheries.
Consumer benefits	**Direct/Indirect** - Insignificant **Cumulative** - insignificant **Cumulative Condition**: Race for fish continues with continuation of current harvesting and processing practices.	**Direct/Indirect** - Significant beneficial **Cumulative** - Significant beneficial **Cumulative Condition**: End of race for fish results in improved recovery and product development. Coordination of harvesting and processing activities with activities in other fisheries creates opportunity for improvements in production (recovery, quality, and product development) that would benefit consumers.	**Direct/Indirect** - Significant beneficial **Cumulative** - Significant beneficial **Cumulative Condition**: End of race for fish results in improved recovery and product development. Coordination of harvesting and processing activities with activities in other fisheries creates opportunity for improvements in production (recovery, quality, and product development) that would benefit consumers.	**Direct/Indirect** - Significant beneficial **Cumulative** - Significant beneficial **Cumulative Condition**: End of race for fish results in improved recovery and product development. Coordination of harvesting and processing activities with activities in other fisheries creates opportunity for improvements in production (recovery, quality, and product development) that would benefit consumers.
Environmental benefits	**Direct/Indirect** - insignificant **Cumulative** - insignificant **Cumulative Condition**: Race for fish continues limiting the ability to precisely manage total catch	**Direct/Indirect** - Significant beneficial **Cumulative** - Significant beneficial **Cumulative Condition**: End of race for fish allows for more precise management of total catch and reduction in bycatch with increased soak times.	**Direct/Indirect** - Significant beneficial **Cumulative** - Significant beneficial **Cumulative Condition**: End of race for fish allows for more precise management of total catch and reduction in bycatch with increased soak times.	**Direct/Indirect** - Significant beneficial **Cumulative** - Significant beneficial **Cumulative Condition**: End of race for fish allows for more precise management of total catch and reduction in bycatch with increased soak times.

4.10 Summary of consequences

As noted in Section 4.1, the consequences of the alternatives under consideration are primarily from changes in fishing and processing patterns that are expected to result from the structural and organizational changes resulting from the proposed action. The most significant structural change resulting from the three-pie voluntary cooperative program is the imposition of a new allocation formula for the BSAI crab fisheries that allocate harvester shares to vessel owners and captains, processor shares to processors, C/P shares to C/P, increase CDQ allocations, and provide community protection measures. The most significant structural changes resulting from an IFQ program is the allocation of harvester shares to participants in the BSAI crab fisheries. The most significant structural changes resulting from a cooperative program is the allocation of shares to cooperatives and the coordination between harvesters and cooperatives. These significant organization changes would eliminate the olympic-style race for fish and allow for rationalization of the fisheries.

These major structural and organizational changes are expected to affect patterns of crab fishing and processing in the BSAI. Among the possible changes examined in this chapter are:

- **Effects on crab fishing patterns.** How will each of the alternatives affect when and where crab fishermen chose to fish?

- **Effects on fleet composition.** How will each of the alternatives affect composition of the crab fishing fleet?

- **Effects on crab processing patterns.** How will each of the alternatives affect crab processing (i.e., processing locations, product forms, and recovery rates)?

The task of describing how a particular fishery is expected to conduct itself under a comprehensive new set of rules involves some degree of conjecture and speculation. This is because the circumstances that lead fishermen and industry to behave in a certain manner are dependent on a wide variety of unpredictable factors including weather patterns, sea ice conditions, the migratory patterns of target species, worldwide market conditions, other regulatory changes, and a host of other factors that are difficult or impossible to predict. Nevertheless, the re-organization of the BSAI crab fisheries under the rationalization program alternatives would result in certain predictable changes to fishing and processing practices and these changes will have some predictable environmental and economic consequences.

Sections 4.2 through 4.5 examined the how these projected changes to crab fishing and processing patterns are expected to affect the physical, biological, and human resources of the BSAI, and the intensity of the effects.

4.10.1 Summary of the environmental effects of the alternatives

Changes to fleet composition. The composition of fishing fleets evolves in response to many variables including management measures, changing costs, and availability of target species. Under each of the rationalization program alternatives, it is assumed the BSAI crab fleet would experience reductions in fleet size. Allocation of harvest shares under the rationalization alternatives would allow for the use of allocations by the most efficient operators and would encourage the removal of marginal vessels from the fleet.

Changes to fishing patterns: Temporal dispersion. The emergence of harvest share allocations in the BSAI crab fisheries would eliminate the race for fish and result in slower paced fisheries. Under the system of harvest share allocations, each operator is issued a fixed quota which may be fished or leased to other operators. Fishermen are, therefore, assured the opportunity to harvest a fixed amount of crab and no longer need to race for fish in competition with the rest of the fleet to assure their harvest. Harvesting and processing activities may disperse temporally for logistic or market reasons. For example, participants may choose production times to avoid conflicts with the groundfish fisheries, so that the same crews and facilities may be more efficiently used in multiple fisheries. And finally, differences in markets may lead different participants to operate at different times of the year to take advantage of market opportunities. The rationalization program alternatives would provide flexibility to participants in the BSAI crab fisheries who previously had to compete for harvests in each crab opening. Removal of the time pressure associated with the race for fish would permit harvesters to reduce bycatch by fishing more selectively and allowing longer pot soaks, which allows gear to sort harvests. The removal of the time pressure should also allow participants to search longer for pots, thus, reducing lost pots and mortality.

Changes to fishing patterns: Spatial dispersion. Under the rationalization program alternatives, the BSAI crab fisheries may disburse more widely on a spatial basis than has been the case in previous years. The most significant reason for this increased spatial dispersion may be the slower pace of fishing under the each of the alternative rationalization programs. If harvesters share fishing information, however, this could lead to less dispersion in the fishery over time. Under a rationalization program, harvesters would have more time to find optimal fishing grounds containing congregations of legal male crabs, thus reducing bycatch and increasing fishing efficiency.

Changes to processing patterns. The rationalization alternatives would also change processing patterns as temporal pressures on processing are removed allowing more time for improved recovery, quality, and product development. The effects of the alternatives on processor participation could differ. The three-pie voluntary cooperative alternative's regional and community protections could result in the fisheries supporting processing activity in locations where facilities might otherwise be closed (particularly in years of low total harvests). In addition, the processor protections of the three-pie voluntary cooperative and the cooperative alternatives could limit processor consolidation.

Effects of the alternatives on the environment. This EIS examines how the alternatives and projected changes to crab fishing and processing patterns are expected to affect the physical and biological resources of the BSAI. Table ES-1 displays the major conclusions with respect to environmental impacts of the alternatives. In summary, for all of the components of the environment analyzed, the alternatives have been found to have similar effects and those effects are either insignificant or unknown.

Table 4.10-1 Summary of the predicted environmental effects of the alternatives.

Biological Issues	Alternative 1 Status Quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative	Comments and Summary
Effects on the physical environment					
Benthic species and habitat	I	I	I	I	Pot gear is used exclusively in the BSAI crab fisheries. The use of pot gear in the BSAI crab fisheries is not expected to have significant impacts on benthic habitat and EFH.
Essential fish habitat	I	I	I	I	
Effects on marine mammals					
Steller sea lions	I	I	I	I	These species do not prey on crab and their primary range does not significantly overlap with primary crab fishing areas during fishing seasons.
ESA-listed cetaceans	I	I	I	I	
Bearded Seal	I	I	I	I	This species prey on snow crab however, their primary range does not significantly overlap with primary snow crab fishing areas due to ice cover.
Effects on crab and other benthic species					
Crab species	I	I	I	I	None of the alternatives would affect total removals of crab or the harvest level setting process.
Bycatch of Benthic species in crab fisheries	I	I	I	I	None of the alternatives would affect total removals of other species caught as bycatch and current levels are very low.
Effects on seabirds					
ESA-listed seabirds	I	I	I	I	These species do not prey primarily on crab and their primary range does not significantly overlap with primary crab fishing areas during fishing seasons.
Ecosystem effects					
Predator-prey relationships	U	U	U	U	Concentrated removals of crab has not been a concern in the status-quo regime. The effects of a more dispersed fishery under Alternatives 2 through 4 on predator-prey relationships are considered unknown.
Energy flow and balance	I	I	I	I	Combined evidence regarding the level of discards relative to natural sources of detritus and no evidence of changes in scavenger populations that are related to discard trends suggests that all of the alternatives would have insignificant ecosystem impacts through energy removal and redirection.

Table 4.10-1 (Cont.) Summary of the predicted environmental effects of the alternatives.

Biological Issues	Alternative 1 Status Quo	Alternative 2 Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative	Comments and Summary
Biological diversity	I	I	I	I	No fishing-induced extinctions of crab or other marine species have been documented in the last 30 years or so. No fishing-induced changes in trophic diversity have been detected under the current management regime.

Notes:
BSAI - Bering Sea and Aleutian Islands
EFH - essential fish habitat
ESA - Endangered Species Act
IFQ - individual fishing quota

S- Significant negative
I Insignificant
S+ Significant positive
U Unknown

4.10.2 Summary of the economic and socio-economic effects of the alternatives

The EIS examines the economic and socio-economic effects of the alternative rationalization programs. Impacts on safety, harvester efficiency, processing efficiency, the distribution of benefits between the harvesting and processing sectors, consumers, captains and crew, and affected coastal communities are examined and summarized below. Tables ES-2, ES-3, and ES-4 display major conclusions with respect to the economic and socio-economic effects of the alternatives.

Safety. Commercial fishing is a dangerous occupation. From 1990 to 2001, 61 total fatalities occurred and 25 vessels were lost in BSAI crab fisheries. This occupational fatality rate is about 28 times the national average. Under the current management regime, harvesters must compete to obtain a share of the harvest creating an incentive to take risks in the fishery. Moreover, this management may lead to lower profit margins and, indirectly, to less investment in, or attention to, safety. A rationalization program would allow fishermen more flexibility in the timing of their harvests, reducing the incentive to compromise safety. In addition, a rationalization program should increase the profitability of the fishery and may indirectly lead to increased investment in safety. These factors should reduce risks of death, injury, and property loss in BSAI crab fisheries. Processors in the current fisheries are subject to similar time pressures as harvesters. The slowing of the race for fish could also provide an opportunity for improved safety at processing facilities.

Effects on harvester efficiency. The allocation of harvest shares in the fisheries under all of the rationalization alternatives should result in improved harvest efficiencies (revenues less costs). Harvesters would be able to make production decisions based on cost and revenue impacts without the need to race to preserve market shares. Regional landing requirements (in the three-pie voluntary cooperative alternative and the IFQ alternative) and the community protections (in the three-pie voluntary cooperative alternative) could reduce efficiency gains. Industry coordination under the cooperative programs could facilitate intra-cooperative efficiencies.

Table 4.10-2 Summary of predicted economic and socio-economic effects of the alternatives.

	Alternative 1 Status quo	Alternative 2 (Preferred Alternative) Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Harvester efficiency - revenues less costs	Harvester efficiency remains at current level - efficiency is sacrificed by the race for fish.	1) Harvester efficiency improves with allocation of harvest shares and end of the race for fish. 2) Efficiency may be reduced by regional and processor share landing requirements and community protections (industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss). 3)Processor shares limit market for landings. 4) Arbitration has ex vessel pricing effects.	1) Harvester efficiency improves with allocation of harvest shares and end of the race for fish. 2) Efficiency may be reduced by regional landing requirements. 3) Market for landings is unrestricted by processor landing requirements.	1) Harvester efficiency improves with allocation of harvest shares and end of the race for fish. 2) Efficiency may be reduced by cooperative processor landing requirements (industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss). 3) Cooperative landing requirements and structure limits market for landings.
Processor efficiency - revenues less costs	Processor efficiency remains at current level - efficiency is sacrificed by time pressures on processing resulting from the race for fish.	1) Processor efficiency improves with end of the race for fish. 2) Efficiency at the processing entity level may be increased by ability of processors to coordinate deliveries using leverage of processor shares. 3) Arbitration effects ex vessel prices. 4) Landing requirements and community protections may reduce efficiency (industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss).	1) Processor efficiency improves with the end of the race for fish. 2) Processors compete for landings with ex vessel price. 3) Efficiency may be reduced by regional landing requirements.	1) Processor efficiency improves with end of the race for fish. 2) Efficiency at the processing entity level will be increased by cooperative processor landing requirements. 3) Efficiency across processors could be reduced by share forfeiture rule for changing cooperatives (industry cooperation, both in the harvest sector and between harvesters and processors, could mitigate any efficiency loss).

Table 4.10-2 (Cont.) Summary of predicted economic and socio-economic effects of the alternatives

	Alternative 1 Status quo	Alternative 2 (Preferred Alternative) Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Production efficiency (sum of harvesting and processing efficiencies)	Efficiency remains at current level - efficiency is sacrificed by time pressures resulting from the race for fish.	1) Efficiency improves with end of the race for fish. 2) Coordination may increase by voluntary cooperatives 3) Processing shares allow processors to coordinate deliveries but limit harvesters' ability to respond to market 3) Arbitration effects may mitigate some loss of efficiency from processor share market restriction 4) Regional and community landing requirements and community protections may reduce efficiency	1) Efficiency improves with end of the race for fish. 2) Regional landing requirements could limit ex vessel market decisions. 3) Transaction costs in markets could reduce overall efficiency.	1) Efficiency improves with end of the race for fish. 2) Coordination may increase by cooperative structure. 3) Cooperative landing requirements will limit efficiency gains.
Effects on captains and crew	1) Short seasons limit earning abilities of captains and crew. 2) Crew shares provide participants with a portion of vessel revenues.	1) Extended seasons with fewer vessels provide steady employment to fewer crew. 2) Competition for jobs could reduce compensation or result in change to wage system for some crew. 3) C shares could have effect on negotiating leverage of holders, but this is severely diminished by processor share landing requirement after three years.	1) Extended seasons with fewer vessels provide steady employment to fewer crew. 2) Competition for jobs could reduce compensation or result in change to wage system for some crew. 3) C shares should provide some negotiating leverage to holders.	1) Extended seasons with fewer vessels provide steady employment to fewer crew. 2) Competition for jobs could reduce compensation or result in change to wage system for some crew. 3) C shares should provide some negotiating leverage to holders.
Effects on consumers	1) Time constraints from short seasons limit ability of industry to improve quality and recovery, add value, and engage in product development.	1) Removal of time constraints allow industry to improve quality and recovery, add value, and engage in product development.	1) Removal of time constraints allow industry to improve quality and recovery, add value, and engage in product development.	1) Removal of time constraints allow industry to improve quality and recovery, add value, and engage in product development.

Table 4.10-2 (Cont.) Summary of predicted economic and socio-economic effects of the alternatives

	Alternative 1 Status quo	Alternative 2 (Preferred Alternative) Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Effects on environmental benefits	1) Race for fish reduces soak times and limits ability to precisely manage total harvests reducing environmental benefits.	1) Reduced time constraint results in longer soak times, reduction in lost gear, and reduced bycatch increasing environmental benefits. 2) Allocation of harvest shares allows more precise stock management increasing environmental benefits.	1) Reduced time constraint results in longer soak times, reduction in lost gear, and reduced bycatch increasing environmental benefits. 2) Allocation of harvest shares allows more precise stock management increasing environmental benefits.	1) Reduced time constraint results in longer soak times, reduction in lost gear, and reduced bycatch increasing environmental benefits. 2) Allocation of harvest shares allows more precise stock management increasing environmental benefits.

Effects on processing efficiency. Under all of the rationalization alternatives, processing efficiency (revenues minus costs) should improve with the end of the race for fish, allowing processors to improve product recovery and quality as well as develop high-value products. In the three-pie voluntary cooperative alternative, efficiency gains would depend on the ability of processors to use processing shares to coordinate deliveries and the balancing of harvesting and processing efficiencies by the arbitration program. The regional landing requirements and community protections could reduce efficiencies. Under the IFQ alternative, harvesters would coordinate deliveries in a manner that facilitates processor efficiencies to obtain the highest ex-vessel price. Regional landing requirements could reduce efficiency under this alternative. Processors would use the cooperative landing requirements to coordinate deliveries and realize processing efficiencies. Efficiency across processors could be reduced by the rules related to cooperative transfers.

Effects on production efficiency. All of the rationalization alternatives should result in improved production efficiencies (the sum of harvest efficiency and processing efficiency). Efficiency gains are derived primarily from slowing the race for fish, allowing both sectors to reduce inputs costs. The restrictions that limit the ability of participants to respond to market conditions and the provisions that facilitate coordination both within and across the sectors will also affect efficiency gains in production.

Effects on captains and crew. Under current management, short harvest seasons limit the earning ability of captains and crew. The rationalization alternatives remove vessels from the fisheries, reducing the number of captains and crew employed. Competition for positions could affect compensation or result in a wage system for some captains and crew. All three rationalization program alternatives allocate 3 percent of the total allowable catch (TAC) to captains as C shares and establish a crew loan program. C shares, however, should provide some negotiating leverage to holders of those shares, but his will be severely limited by processor share landing requirements after 3 years.

Effects on consumers. The current management leads to a race for fish that limits the ability of the industry to devote efforts to improving recovery and quality, and limits the development of new products. Under the rationalization alternatives, the removal of the race for fish should lead to product developments and improved recovery and quality that would benefit consumers.

Effects on environmental benefits. All three rationalization alternatives are likely to contribute environmental benefits from both improved fishing practices and improved management of stocks. Changes in the fisheries under rationalization and their effects on stocks, however, cannot be fully predicted. Increased soak times are anticipated in a rationalized fishery. These increases could lead to improved sorting of harvests by gear reducing the amount and handling of discards in the fishery. A reduction of discards is likely to reduce mortality to the benefit of stocks.

Impacts to communities. A range of Alaska communities from the northern Bering Sea to the western Aleutians to the Southeast panhandle are engaged in the crab fisheries through different combinations of harvesting, processing, and/or fishery support activities. A number of these communities may be considered substantially dependent upon the BSAI crab fishery. Additionally, a number of communities in the Pacific Northwest are home ports to a significant portion of the crab fleet, and Seattle features the greatest concentration of sectors of any community. Under status quo, these communities experience the adverse impacts associated with overcapitalization and the race for fish. The rationalization program alternatives would alleviate these adverse impacts, however, the benefits would not be distributed evenly among the affected communities due to the specific components of each alternative. Impacts on these communities would be linked with beneficial effects that would result in the establishment of a stable long-term supply of crab to local shore-based processing plants and adverse effects of processors and harvesters exiting a community. Under the three-pie voluntary cooperative program, generally, the communities with substantial recent history of participation in the crab fisheries would receive the majority of the benefits, whereas communities with less substantial recent history would receive less benefits and may even loose some of their harvesting and processing abilities as the industry consolidates. This is mainly due to the community protection measures developed for that alternative. Under the IFQ alternative, it is predicted that there would be considerable distributional shifts among communities as harvesters and processors consolidate and as the changes in the prosecution of the fisheries facilitate changes in landing and processing locations (Tables ES-3 and ES-4). The cooperative program, because it establishes a closed class of processors, provides some degree of protection for processors, however, consolidation would still occur similar to the IFQ program.

Impacts to Community Development Quota groups. The Western Alaska Community Development Quota (CDQ) program allocated 7.5 percent of the BSAI crab harvests to 65 western Alaska communities. The purpose of the program is to support fisheries-related economic development. Six managing organizations of CDQ groups represent the communities. No negative impacts would be realized by these groups as a result of any of the rationalization program alternatives. Under each alternative to status quo, the overall allocation to the CDQ program would increase from 7.5 percent to 10 percent of the BSAI crab harvest for each fishery, except Norton Sound red king crab. The change amounts to a 33 percent increase in the overall CDQ crab allocation. Also, the rationalization program alternatives would add a 10 percent allocation for Aleutian Islands golden king crab and western Aleutian Islands red king crab, fisheries that are not currently in the CDQ program. Increasing the allocation would increase the royalties earned by CDQ groups and enable them to invest more in projects intended to benefit the 65 communities that belong to CDQ groups.

Table 4.10-3 Summary of community impacts - harvesters.

	Alternative 1 Status quo	Alternative 2 (Preferred Alternative) Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Regionally based harvesters	1) Areas of residence suffer from continued inefficiencies and overcapitalization resulting from the race for fish. 2) Support services are geared toward meeting more temporary peak demands.	1) Communities of harvesters receiving allocations benefit from stability in fisheries but total number of vessels and crew employment may decline. 2) Transfers of shares will benefit communities of purchasers and will harm communities of sellers. 3) Provision of support services stabilizes with longer season with possible reduction in number of providers and employment. 4) Impacts vary across communities with importance of crab fleet to local economy. 5) Cooperatives may facilitate consolidation. 6) Regionalization and community protections may slow and limit extent of consolidation. 7) CDQ communities and Adak benefit from share allocations.	1) Communities of harvesters receiving allocations benefit from stability in fisheries but total number of vessels and crew employment may decline. 2) Transfers of shares will benefit communities of purchasers and will harm communities of sellers. 3) Provision of support services stabilizes with longer season with possible reduction in number of providers and employment. 4) Impacts vary across communities with importance of crab fleet to local economy. 5) Consolidation of open market share trading may be slower but more permanent. 6) Regionalization limits consolidation across regions. 7) CDQ communities and Adak benefit from share allocations.	1) Communities of harvesters receiving allocations benefit from stability in fisheries but total number of vessels and crew employment may decline. 2) Transfers of shares will benefit communities of purchasers and will harm communities of sellers. 3) Provision of support services stabilizes with longer season with possible reduction in number of providers and employment. 4) Impacts vary across communities with importance of crab fleet to local economy. 5) Cooperatives may facilitate consolidation. 6) CDQ communities and Adak benefit from share allocations.

Table 4.10-4 **Summary of community impacts - processors.**

	Alternative 1 Status quo	Alternative 2 (Preferred Alternative) Three-pie voluntary cooperative	Alternative 3 IFQ	Alternative 4 Cooperative
Regionally based processors	1) Communities with processors suffer from continued inefficiencies and overcapitalization resulting from the race for fish but distribution of landings may benefit some communities. 2) Support services are geared toward meeting more temporary peak demands.	1) Communities of processors receiving allocations benefit from stability in fisheries. 2) Transfers of shares will benefit communities of purchasers and will harm communities of sellers. 3) Provision of support services stabilizes with longer season with possible reduction in number of providers and employment. 4) Impacts vary across communities with importance of crab processing to local economy. 5) Regionalization and community protections may slow and limit extent of consolidation. 6) Specific areas (Pribilofs and Western Aleutians) benefit from regionalization.	1) Communities able to retain or attract processing benefit from stability in fisheries. 2) Transitions (on implementation and stock declines) harm communities unable to retain historic processing. 3) Provision of support services in communities able to retain or attract processing stabilizes with longer season with possible reduction in number of providers and employment. 4) Impacts vary across communities with importance of crab processing to local economy. 5) Regionalization may slow and limit extent of consolidation.	1) Communities of processors with cooperative associations benefit from stability in fisheries. 2) Changes in cooperative associations benefit communities that attract associations and harm communities that lose associations. 3) Provision of support services in communities able to retain or attract processing stabilizes with longer season with possible reduction in number of providers and employment. 4) Impacts vary across communities with importance of crab processing to local economy. 5) Cooperative associations may slow or reduce extent of consolidation.