

APPENDIX F

Bycatch

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ACRONYMS AND ABBREVIATIONS

ABC	acceptable biological catch
ADF&G	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center
AFA	American Fisheries Act
BSAI	Bering Sea and Aleuttian Islands
CDQ	Community Development Quota
ESA	Endangered Species Act
EFH	essential fish habitat
EEZ	Exclusive Economic Zone
EFP	experimental fishing permit
FCZ	Fishery Conservation Zone
FMP	Fishery Management Plan
ft	feet/foot
GOA	Gulf of Alaska
IR/IU	Improved Retention/Improved Utilization
IFQ	individual fishing quota
IPHC	International Pacific Halibut Commission
JV	joint venture
MMPA	Marine Mammals Protection Act
MRA	maximum retainable amount
MSA	Magnuson-Stevens Fishery Conservation and Management Act
mt	metric tons
NEPA	National Environmental Policy Act
nm ²	square nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fisheries Management Council
NPO	North Pacific Ocean
PSC	prohibited species catch
SCA	Steller Sea Lion Conservation Area
TAC	total allowable catch
U.S.	United States
VIP	Vessel Incentive Program

Section 1 **Bycatch**

The principal goal of the North Pacific Fisheries Management Council (NPFMC) and National Marine Fishery Service (NMFS or National Oceanic and Atmospheric Administration [NOAA] Fisheries) is to maximize the benefits of North Pacific groundfish resources for the overall good of the people and the environment. NPFMC¹ decisions are based upon a number of biological and socioeconomic considerations all of which must be weighed when determining management and conservation strategies. A core objective of the NPFMC is to maximize the sustainable yield of the groundfish fishery at minimal cost, while at the same time ensuring the sustainability of targeted stocks. Management policies must also act in conjunction with other conservation goals such as the protection of non-target fish species, marine mammals, seabirds, and Essential Fish Habitat (EFH). Socioeconomic considerations include the effects that groundfish management policies might have on other commercial, recreational, and subsistence fisheries of the Pacific Northwest. Amid all of these concerns, the NPFMC must also comply with specific bycatch mandates in the Magnuson-Stevens Fishery Conservation and Management Act (MSA). These include: 1) National Standard 9 which states that “Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.” and 2) Section 303 which states that Fishery Management Plans (FMPs) are required to “establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures that, to the extent practicable and in the following priority (A) minimize bycatch; and (B) minimize the mortality of bycatch which cannot be avoided.”

Bycatch is defined in the MSA as fish that are harvested in a fishery but which are not sold or kept for personal use. This includes the portion of the catch that is discarded back into the sea and unobserved mortality due to a direct encounter with fishing gear that does not result in the capture of that species by a fisherman. The latter also includes dropoff and escapement mortality. Discards include species that must be returned to the sea by law (regulatory discards), and fish that are discarded at the discretion of the fisherman because they are not economically worthwhile to keep (economic discards). Fish taken as bycatch often suffer high mortality. Bycatch mortality can decrease the sustainability of a fishery and the net benefits provided by that fishery, in four ways. First, if bycatch mortality is not monitored adequately, it increases the uncertainty concerning total fishing-related mortality, which in turn makes it more difficult to assess the status of stocks of fish and other bycatch species, to set the appropriate optimum yield and overfishing levels for fish stock, and determine acceptable levels of bycatch for other bycatch species. Inadequately monitored bycatch mortality also makes it difficult to ensure that the optimum yields are attained, that overfishing does not occur and that the acceptable levels of bycatch for other species are not exceeded. Second, if discards are sufficiently concentrated in time and space, they will result in localized environmental degradation. Third, bycatch mortality precludes some other uses of living marine resources. For example, juvenile fish that are subject to bycatch mortality cannot contribute directly to the growth of that stock and to future catch. Nor can they be available as prey for other species. Bycatch is a wasteful use of living marine resources if it precludes a higher valued use of those resources. Fourth, in the absence of management measures designed to reduce bycatch, there will typically be too much bycatch; however, without adequate information concerning the biological, ecological, social, and economic effects of a set of bycatch management measures, it is difficult to ensure that those measures will not decrease the overall benefits to the Nation.

If the problem is due principally to uncertainty concerning fishing related mortality, improved bycatch monitoring systems should be considered and may be sufficient to solve the bycatch problem. If the problem is principally localized environmental degradation, it may be possible to solve the problem effectively and efficiently by controlling the temporal and spacial distribution of discards. If the problem is excessive human induced mortality for a particular stock and there are several sources of that mortality, the merits of reducing the alternative sources of mortality should be considered. For example, in the case of overfishing, the solution

¹ NPFMC decisions are subject to approval by NOAA Fisheries. For further detail on the relationship between the NPFMC and NOAA Fisheries, please refer to Section 2.4 of the Programmatic SEIS.

could be to decrease the catch or bycatch of that stock or both. The appropriate choice will depend on the marginal net benefit of each of these two uses of the stock that is being overfished.

If it is determined that the bycatch rate of a fishery is too high, there are two general types of solutions, both dealing with regulations. First, regulations can be developed and implemented that prohibit fishermen from fishing in ways that result in high levels of bycatch. For example, regulations can prohibit fishing in specific times or areas, can require the use of specific gear or gear modifications, and can restrict the use of catch or the level of bycatch. These are command and control solutions. Second, regulations can be developed and implemented to eliminate or decrease incentives (i.e., externalities) that result in fishermen taking high levels bycatch. Typically, much of the benefit of reducing bycatch accrues to others, not to the fisherman who modifies his fishing practices to decrease bycatch. The benefits others receive are external to the fisherman's decision-making process; therefore, from society's perspective, the fisherman does not do enough to reduce bycatch. The externalities are the source of the excess bycatch problem, and in some cases decreasing the externalities will be the appropriate solution. But that will require holding individual fishermen accountable for their bycatch, and the monitoring required to do that may not be feasible. The regulations that decrease incentives can be referred to as market oriented solutions.

With sufficient information, fishery managers could identify the best way for each fisherman to decrease its bycatch. The difficulty is that fishery managers have relatively limited and usually static information. Individual fishermen usually have more complete and more timely information concerning methods for decreasing bycatch, but as noted above, they may lack the appropriate incentives. In selecting the management approach that will be used to decrease bycatch, it is important to be realistic about information deficiencies and the difficulty of providing the correct incentives to fishermen. Research concerning the response of fish and other bycatch species to fishing gear and fishing operations can assist in developing effective and efficient methods for reducing bycatch and bycatch mortality. Such research is also necessary to determine the extent to which a change in gear or fishing practices decreases bycatch as opposed to, for example, just replacing discard mortality with unobserved fishing mortality.

Although the information required to precisely estimate the net benefits of bycatch reduction solutions will seldom be available, an effort should be made to consider both the benefits and costs of the alternative strategies, where the benefits and costs are broadly defined to address the biological, ecological, social, and economic effects of bycatch and bycatch management. Such an approach is required for obtaining good stewardship and to meet federal regulatory mandates, including those in the MSA, the Marine Mammals Protection Act (MMPA), the Endangered Species Act (ESA), the National Environmental Policy Act (NEPA), the Regulatory Flexibility Act, and Executive Order 12866. Outreach and public debate to obtain information concerning the benefits and costs of the alternatives can be done through the NPFMC and NOAA Fisheries processes which may be used to develop and evaluate alternatives. In general, more complete information concerning the biological, ecological, social, and economic effects of bycatch and methods for reducing bycatch are required to develop more effective and efficient methods for managing bycatch. As more efficient methods for reducing bycatch are developed, further reductions in bycatch will become practicable.

Many of the species that are protected under FMP amendments that limit bycatch are the targets of other commercial, recreational, and subsistence fisheries in Alaska. Excessive bycatch mortality in the groundfish fishery could affect the viability of these other domestic fisheries and the people and economies that depend on them. However, bycatch restrictions place greater economic burdens on the groundfish industry either by limiting fishing or reducing fishing efficiency. Compliance with time/area closures and bycatch release standards can require considerable expenditures of time and effort by the fishermen.

Mortality is a key consideration when assessing measures that might decrease bycatch. If all discards could safely be returned to the sea unharmed, bycatch would be less of a conservation issue and higher levels of bycatch would be acceptable. However, because discard mortality rates for many species approach or equal 100 percent, efforts to reduce bycatch mortality typically focus on decreasing bycatch. But for some species, such as Pacific halibut, there have been substantial efforts to decrease discard mortality rates. In some instances, the adverse effects of bycatch were sufficiently high and the expectations for decreasing bycatch

were sufficiently low that specific fisheries have been prohibited; e.g., there is a total ban on the use of seines and gillnets in the groundfish fishery and bottom trawl gear is prohibited in the BSAI pollock fishery. In general, FMP policy attempts to minimize bycatch and bycatch mortality to the extent practicable, where practicality is determined by the broadly defined benefits and costs of decreasing bycatch and bycatch mortality.

This paper provides a broad qualitative overview of the four proposed management policies as they pertain to the regulation of bycatch in the North Pacific groundfish fishery of the Bering Straits/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) regions. Its goal is to provide the reader with a basic understanding of each potential policy and the biological, physical, and socioeconomic consequences of each alternative. It also identifies information gaps or other shortcomings that may impede specific components within any of the proposed alternatives.

Section 2 Historical Perspective on Bycatch

Management of bycatch in the North Pacific groundfish fishery has historically focused on Pacific halibut, Pacific herring, salmon, and crabs (Table 1). Prior to 1976, the groundfish fishery in the BSAI and GOA management regions was conducted almost exclusively by foreign fleets and management regulations were implemented through bilateral or multilateral agreements. The Fishery Conservation and Management Act of 1976, which later became the MSA, established a Fishery Conservation Zone (FCZ) which became the Exclusive Economic Zone (EEZ) extending some 200 miles off United States (U.S.) shores and fishing within this area fell under U.S. jurisdiction. Following passage of the MSA, preliminary FMPs established management measures to reduce bycatch by these foreign fleets. Measures included time and area closures; prohibitions on the retention of halibut, crabs, salmon, herring, and shrimp (prohibited species catch [PSC]); the establishment of a limited observer program; and restrictions on the use of bottom trawls. By the early 1980s, bycatch control measures began to be directed at the burgeoning domestic groundfish fishery. For the first time in the GOA, domestic trawlers had bycatch limits placed on halibut, which, when reached, prohibited fishing with other than off-bottom trawls.

By 1985, the presence of foreign fishing fleets within the EEZ had greatly diminished, and management attention began to focus on the rapidly developing joint venture (JV) fisheries and the completely domestic groundfish fisheries. Bycatch limits were applied to domestic fisheries operating throughout the GOA, while these limits were not mandated for the BSAI until later. Additional measures to reduce bycatch included requiring biodegradable panels on sablefish pots was, and that observers be present on all joint venture processing vessels.

From 1986 to 1990, major policy emphasis was placed on reducing bycatch of PSC in the domestic fishery. Extensive time and area closures were implemented around Kodiak Island and the eastern Bering Sea to protect red king crab. Bycatch limits were set in the BSAI for halibut, red king crab, and bairdi Tanner crab. In 1990, a bycatch limit was placed on herring for the trawl fleet. Bycatch limits were applied to the entire domestic fishing fleet based upon area, season, and fishery sector. PSC restrictions closed down select fisheries on several occasions.

By 1991, the groundfish fisheries were fully domestic. From 1991 to 1995, PSC bycatch reduction continued to be a major policy goal. Restrictions were placed on the construction and use of fishing gear to reduce the bycatch of both PSC species and juvenile components of target groundfish stocks. Other restrictions included a prohibition on the use of seine and gillnets, minimum mesh size for all trawls, a blanket requirement for biodegradable panels and halibut excluder devices on all groundfish pots, and careful release mechanisms for the longline fishery. In the Bering Sea, PSC limits were established for chum salmon and additional areas were closed to protect red king crab. A herring PSC limit was established for the BSAI trawl fishery. Halibut bycatch limits were redefined in terms of mortality instead of just total bycatch. The implementation of the individual fishing quota (IFQ) program for Pacific halibut and sablefish in 1995 was intended to provide a variety of benefits, including reductions in halibut bycatch. Similarly, the allocation of the Pacific cod total allowable catch (TAC) between trawl and fixed gear was, in part, implemented to reduce halibut bycatch.

Since 1995, conservation efforts to reduce bycatch in the groundfish fishery have continued. In recent years, additional closures in the Bristol Bay area to protect red king crab have been implemented. In the BSAI, PSC limits were established for opilio Tanner crab and chinook salmon, and revised for red king and bairdi Tanner crabs. The BSAI pollock fishery was restricted to the use of off-bottom trawls only. Groundfish retention and utilization programs have been implemented and improved.

Table 1. Chronology of management measures to control bycatch of prohibited species in the groundfish fisheries of the Bering Sea and Aleutian Islands and Gulf of Alaska, 1935-2000.

Effective year	Management action
1935	Trawls prohibited except for shrimp and flounder fishing in Bering Sea and Aleutian Islands (BSAI).
1937	Use of dynamite prohibited in BSAI.
1938	Use of gillnets prohibited for catching halibut in BSAI.
1942	Trawls permitted except for salmon and herring fishing in BSAI.
1944	Use of trawls prohibited for catching halibut in BSAI.
1948	Five-inch minimum mesh size required for trawls in BSAI.
1959	Trawls prohibited for taking any crab species in BSAI. Trawling prohibited in Bristol Bay and king crab pot sanctuary in BSAI
1967	Halibut nursery area closed to halibut fishing in BSAI. Foreign fisheries prohibited around Fox Islands in BSAI.
1969	Pribilof Islands area closed to foreign fishing.
1972	Pot gear prohibited for catching halibut in BSAI.
1973	Use of tangle nets prohibited for catching crab in BSAI.
1974	Catch quotas established for Japanese groundfish fisheries limited effort for BSAI pollock and flatfish and Gulf of Alaska (GOA) Pacific Ocean perch and sablefish.
1975	Catch quotas established for United Soviet Socialist Republic (USSR) groundfish fisheries in BSAI.
1976	Fishery Conservation and Management Act passed, providing National Standards and regulations for managing federal fisheries to 200 miles.
1977	Preliminary groundfish Fishery Management Plans (FMPs) implemented with groundfish optimum yields; closures of foreign fisheries when any one species limit is attained; several closure areas in BSAI and GOA extended from bilateral agreements; prohibited status for halibut, salmon, crabs, and shrimp.
1979	GOA FMP implemented with no retention of prohibited species (salmonids, halibut, shrimp, herring, crab, scallops); expansion of time-area closures to reduce halibut expansion of time-area closures to reduce halibut of total allowable level of foreign fishing (TALFF) taken December 1 to May 31 to minimize halibut bycatch; domestic trawlers restricted by halibut prohibited species catch (PSC) limits for five areas for December 1-May 31; halibut and Tanner crab PSC limits for domestic fishermen included; depth restrictions on use of foreign longlines seaward of 500 meters (m) May 1-September 30 to minimize bycatch of halibut. Created new species optimum yield (OY) for grenadiers (rattails) to protect them from bycatch (since rescinded, GOA-5). Pacific cod TALFF allocated to foreign longlines around Chirikov to reduce bycatch of other species, permitted directed longlining for Pacific cod to reduce halibut bycatch, required foreign vessel operators to report bycatch and discard of salmon and halibut.
1980	Set GOA OY, required biodegradable panels on sablefish pots to minimize bycatch of small sablefish, and established four species categories (target, PSC, unallocated, other) (GOA-8).
1982	BSAI FMP implemented with specific management objective to rebuild halibut; established PSC category for halibut, salmon, crabs; expanded time-area closures for foreign fisheries to reduce bycatch of juvenile halibut, set bycatch policy for domestic fishermen; set target observer coverage in foreign fisheries at 35-40 percent. Set chinook PSC of 65,000fish for foreign trawl fishery (BSAI-1a). Closed waters east of 140° W to West (GOA-10). Prohibited pot longline gear for sablefish, partially to eliminate ghostfishing (GOA-12).

Table 1 (cont.). Chronology of management measures to control bycatch of prohibited species in the groundfish fisheries of the Bering Sea and Aleutian Islands and Gulf of Alaska, 1935-2000.

Effective year	Management action
1983	PSC bycatch reduction schedule established for BSAI foreign trawl fishery, allowed domestic trawling in pot sanctuary and halibut savings area in BSAI, set 1986 goal of 17,473 salmon (BSAI-3). Closed GOA southeast to foreign trawl fisheries to protect halibut, allowed foreign longlines to fish shallower than 500 m in winter halibut savings area, until halibut bycatch reached 105 metric tons (mt).
1984	Set BSAI groundfish OY cap at 2 million mt, allowed domestic trawling in winter halibut savings area with observers and Bristol Bay pot sanctuary until halibut PSC limit is reached (BSAI-7). Raised halibut PSC to 270 mt in western GOA and 768 mt in central GOA and exempted domestic pelagic trawl fishery from halibut PSC limit.
1985	Set BSAI salmon PSC at 27,957 salmon (26,000 chinook) (BSAI-8). Established reporting requirements and directed fishing definitions (BSAI-9, GOA-14). Revised OYs and implemented framework for setting and revising halibut PSC limits (GOA-14).
1987	PSC bycatch limits and zones established in BSAI domestic and joint venture (JV) flatfish trawl fisheries, set Bristol Bay trawl closure area (Area 512) to all trawling year-round, allowed RD discretion to set target species as PSC once TAC is reached (BSAI-10). Established four red King crab bottom trawl closed areas during February 15-June 15 around Kodiak Island to protect crab, revised Oys, implemented framework for setting and revising PSC limits, revised reporting requirements (GOA-15).
1988	Began pilot observer program in Dutch Harbor and Kodiak, revised acceptable biological catch (ABC) definition (BSAI-11). Added steelhead and salmon to PSC list and established target, other, and nonspecified categories, required 30-day comment period for annual specifications and PSC limits (BSAI-11a/GOA-16).
1989	Required weekly reporting, established PSC limits for foreign and JV fisheries, set limits on retention of bycatch after target fishery closes (BSAI-12/GOA-17). Area 516 closed to trawling seasonally during crab molting period. Endorsed voluntary herring bycatch plan. Adopted policy on full utilization of BSAI and GOA groundfish.
1990	Established crab and halibut PSC limits (BSAI-12a). New observer program, data reporting system, and directed fishing standards implemented (BSAI-13/GOA-18). Pot, jig, hand, and troll gear exempted from GOA halibut PSC limits.
1991	Allowed seasonal apportionment of PSC limits, established vessel incentive program (VIP) to reduce bycatch rates of red king crab and halibut bycatch, refined overfishing, specification process and fishing gear definitions (BSAI-16/GOA-21). Established herring savings areas and hotspot authority (BSAI-16a). Season for BSAI yellowfin sole fishery changed to May 1. BSAI flatfish fisheries delayed to May 1 to reduce halibut and crab bycatch.
1992	Regional Administrator authorized to approve experimental fishing permits to reduce bycatch (BSAI-17/GOA-22). Established time and area closures for bycatch reduction, delayed rockfish trawl opening to Monday closest to July 1 to reduce salmon bycatch and groundfish trawl fisheries to January 20 to reduce salmon and halibut bycatch, expanded VIP for all trawl fisheries and GOA, halibut PSC limits established for BSAI non-trawl fisheries, and redefined VIP and PSC limits in GOA (BSAI-19/GOA-24).
1993	Gillnets and seines prohibited for groundfish fishing in BSAI. Careful release requirements established for halibut bycatch in groundfish longline fisheries in BSAI and GOA, halibut PSC limit set at 3,755 mt for halibut trawl fishery with regulatory framework for revisions (BSAI-21). Crab bycatch performance standards set for pelagic trawl fishery in BSAI. Kodiak Island crab protection zones made permanent (GOA-26). Set performance-based pelagic trawl definition in BSAI and GOA. Established a separate species category for Atka mackerel (GOA-31).

Table 1 (cont.). Chronology of management measures to control bycatch of prohibited species in the groundfish fisheries of the Bering Sea and Aleutian Islands and Gulf of Alaska, 1935-2000.

Effective year	Management action
1994	Allocations of Pacific Cod by gear are implemented in the BSAI (BSAI-24). The Allocations will provide fixed allocations for trawl (54 percent), longline/pot (44 percent) and jig gears (2 percent). Seasonal apportionments of Halibut PSC were also included allowing/forcing fishers to avoid high bycatch periods. NPFMC adopts minimum mesh-size requirements for trawl codends used in pollock, cod, and rock sole fisheries in BSAI. NOAA Fisheries published vessel specific bycatch rates on the Internet, required observers to monitor salmon discards, eliminated primary halibut PSC but kept 3,775 mt trawl limit (BSAI-25). Gillnets and seines prohibited.
1995	Halibut and sablefish IFQ program implemented (BSAI-15/GOA-20). BSAI chum salmon savings area, chinook salmon savings area, red king crab savings area, and Pribilof Islands Halibut Conservation Area established to protect crabs (BSAI-21a; 21b; 35). Established minimum trawl mesh size in BSAI. BSAI jig gear exempted from halibut PSC.
1996	BSAI Red King Crab Savings Area permanently established as year-round trawl closure area. Voluntary salmon donation program implemented to reduce bycatch and waste (BSAI-26/GOA-29).
1997	Nearshore Bristol Bay closed to all trawling year-round. PSC limits for red king crab and bairdi Tanner crab reduced and for opilio Tanner crab implemented (BSAI-37; 41). Over-fishing definitions implemented (BSAI-44/GOA-44).
1998	Established PSC limits for opilio Tanner crab in trawl fisheries and opilio Tanner crab bycatch limitation zone (BSAI-40). Improved retention/improved utilization program implemented for pollock and cod (BSAI-49/GOA-49). Prohibited species donation program redefined to include halibut (BSAI-50/GOA-50). Forage fish category and ban on fishing implemented (BSAI-36/GOA-39).
1999	Revised overfishing definitions implemented (BSAI-56/GOA-56).
2000	Bottom trawl ban in BSAI pollock fisheries (BSAI-57). Chinook salmon PSC limits reduced to 29,000 fish in four years (pending) (BSAI-58). GOA demersal shelf rockfish full retention to account for bycatch (pending). Sponge and coral identified as habitat area of particular concern-biota types under prohibited species category in BSAI and GOA (pending).

Section 3 Species Categories Management Tools

The management of bycatch in the North Pacific groundfish fishery involves a number of mechanisms that contribute to an integrated, and at times complex, regulatory framework for implementing the overall policy objectives of the NPFMC. Fishing restrictions such as harvest quotas and gear constraints may vary over time and space in response to population shifts, migratory patterns, and life-cycle characteristics of individual species or species complexes. When sufficient scientific information is available, bycatch measures may be applied to individual species within the BSAI and GOA. In cases where little is understood about the life-history and ecology of particular species, groups of species may be managed as a single complex. The following section provides a breakdown of two major bycatch management elements: 1) the five principal species management categories, and 2) the major bycatch tools used by NPFMC to manage bycatch within those species categories.

3.1 Species Categories

FMP policy is based on five species management categories: 1) target species, 2) prohibited species, 3) forage species, 4) other species listed in the FMPs, and 5) nonspecific species, which includes all remaining species of fish in the BSAI and GOA. Table 2 presents a listing of the species included in these first four categories.

3.1.1 Target Species

Target species are the species targeted by the fishing effort in the groundfish fisheries. The NPFMC may manage target species as individual species or species groups (complex) depending upon the commercial importance of a species and the amount of biological information that is available with which to manage each species or species complex. Species such as pollock, Pacific cod and sablefish are managed as distinct species in both the BSAI and GOA. In contrast, the numerous species of rockfish in the GOA and BSAI are managed as individual species (e.g., Pacific ocean perch) or as several species complexes, the makeup of which may change from year to year.

3.1.2 Prohibited Species

The category prohibited species is an FMP designation for non-groundfish species that are harvested in other domestic fisheries. Listed prohibited species include several species of crabs, Pacific halibut, Pacific herring, steelhead trout, and the five species of Pacific salmon. With the exception of Pacific halibut, fisheries for these species are not directly managed by the NPFMC. The fisheries for these species are managed by a number of state, federal, and/or international agencies or commissions.

3.1.3 Forage Species

Forage fish play a central role in the North Pacific Ocean food chain, consumed by a wide variety of fish, marine mammals, and seabirds. This category includes all species in the families Osmeridae, Bathylagidae, Myctophidae, Ammodytidae, Trichodontidae, Pholidae, Stichaeidae, Gonostomidae, and euphausiid shrimps. Because of their trophic importance, the BSAI and GOA FMPs were amended to prevent the development of a directed fishery on these species, which limits the amount of these species that can be retained in the groundfish fishery.

3.1.4 Other Species

This category consists of species that are not currently commercially important to the groundfish fishery but which might have greater future economic potential. This group includes sharks, skates, sculpins, squids, and octopi. An aggregate TAC is set for these species.

Table 2. Taxa listing for the five Fishery Management Plan management categories.

<p>Targeted Species - Harvested in the North Pacific groundfish fishery</p> <p>Walleye Pollock (<i>Theragra chalcogramma</i>) Pacific cod (<i>Gadus macrocephalus</i>) Flathead sole (<i>Hippoglossoides elassodon</i>) Rock sole (<i>Lepidopsetta</i> spp.; 2 species) Greenland Turbot (<i>Reinhardtius hippoglossoides</i>) Yellowfin sole (<i>Limanda aspera</i>) Arrowtooth flounder (<i>Atheresthes stomias</i>) Other flatfish (8 species) Sablefish (<i>Anoploma fimbria</i>) Rockfish (32 species of the genera <i>Sebastes</i> and <i>Sebastolobus</i>) Atka mackerel (<i>Pleurogrammus monopterygius</i>)</p>
<p>Prohibited Species - Non groundfish species targeted in other domestic fisheries</p> <p>Red king crab (<i>Paralithodes camtschaticus</i>) Blue king crab (<i>P. camtschaticus</i>) Golden or brown king crab (<i>Lithodes aequispinus</i>) Bairdi Tanner crab (<i>Chionoecetes bairdi</i>) Opilio Tanner crab (<i>C. opilio</i>) Pacific halibut (<i>Hippoglossus stenolepis</i>) Pacific herring (<i>Clupea harengus pallasii</i>) Steelhead trout (<i>Oncorhynchus mykiss</i>) Pink salmon (<i>O. gorbuscha</i>) Chum salmon (<i>O. keta</i>) Chinook salmon (<i>O. tshawytscha</i>) Sockeye salmon (<i>O. nerka</i>) Coho salmon (<i>O. kisutch</i>) Sponges and Corals</p>
<p>Forage Species - Important food fish for other fishes, mammals, and seabirds</p> <p>Eulachon, Capelin and other smelts (<i>Osmeridae</i>) Deep-sea smelts (<i>Bathylagidae</i>) Lanternfishes (<i>Myctophidae</i>) Pacific sand lance (<i>Ammodytidae</i>) Pacific sand fish (<i>Trichodontidae</i>) Gunnels (<i>Pholidae</i>) Pricklebacks, Warbonnets, Eelblennys, Cockscombs, and Shannys (<i>Stichaeidae</i>) Bristlemouths, Lightfishes, and Anglemouths (<i>Gonostomidae</i>) Krill (<i>Euphausiid</i> shrimps)</p>
<p>Other Species - Non-forage species of no commercial value but with future commercial potential</p> <p>Sharks Skates Sculpins Octopii Squids</p>
<p>Nonspecified Species - Not managed or monitored</p> <p>All BSAI and GOA fish not listed above including invertebrates. Note that the MSA defines fish as "finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds."</p>

3.1.5 Nonspecified Species

The "nonspecified" species category consists of all species not listed in the four groups above, including invertebrates. None of the species within this group are currently managed or monitored as with the other four categories of species. However, catches of these species in the commercial fishery are recorded by observers, as are catches during survey cruises.

3.2 Management Tools

The NPFMC employs two types of management measures for the BSAI and GOA: 1) framework measures and 2) conventional measures. Framework measures allow the NPFMC to more rapidly respond to biological and socioeconomic changes without amending an underlying FMP. They involve annual or seasonal adjustments such as those applied to TACs and the apportionment of PSC limits. Conventional measures can only be changed by formally amending an FMP. Conventional measures include permits, reporting requirements, gear restrictions, and allocations among user groups. The following subsection provides brief descriptions of major bycatch management tools that are utilized by the NPFMC.

3.2.1 Total Allowable Catch

The NPFMC sets annual TAC or quotas for target species and other species. The TAC defines the total tonnage of a species that may be taken by any means among all groundfish fisheries over the calendar year. TACs for target species include fish taken both as catch and as bycatch in the groundfish fisheries. The TACs can be apportioned by gear type and by season, in part to reduce bycatch and bycatch mortality. For example, seasonal apportionments of pollock TAC in the western and central GOA are intended to prevent the pollock fishery from occurring during periods characterized by high bycatch of salmon. Seasonal or area allocations of TAC also have the effect of directing fishing effort toward periods or areas of high target fish abundance. Therefore, harvests can be maximized while keeping bycatch levels in check. High bycatch rates in a fishery that targets a particular species, have been a factor in the decision to set lower TACs for some such species.

The NPFMC may set TACs for target species and other species either by individual species or species groups. The groupings are based on the commercial importance of a species or species group and the amount of biological information that is available to manage each group or species. The NPFMC may assemble or disassemble target species groups as they see fit based upon changes in population status and available information. The other species category requires an FMP amendment to break out a particular species or species group from a larger grouping.

Prohibited Species Catch Limits

Regulations governing the treatment of prohibited species (halibut, crab, salmon, and herring) seek to reduce the catch of these key non-groundfish species by banning their retention in all groundfish fisheries and requiring that all prohibited species taken in the groundfish fishery be returned to the sea with a minimum of injury. In addition to the general prohibition on retention, the total seasonal bycatch of individual PSC species is limited for red king crab, bairdi and opilio Tanner crabs, Pacific halibut, Pacific salmon, Pacific herring in the BSAI, and Pacific halibut in the GOA. When a PSC limit apportionment of the halibut or crab for a specific fishery and area is reached, that fishery is closed for the remainder of the season in that area even if the target groundfish quota has not been reached. For herring and salmon, the attainment of PSC limits triggers area-and-time specific closures of specific fisheries. Upon attainment of the PSC limit apportionment for a specific fishery, certain sensitive areas of high density and/or critical habitat are closed to that groundfish fishery. The area closure may be temporary, being applicable only to biologically sensitive times of the year (e.g., reproduction, molting, or migration).

Maximum Retainable Amount

Maximum retainable amount (MRA) limits determine the amount of a species by weight that may be retained. MRA is expressed as a percent of total retained catch by a fishing vessel of the species for which targeting is currently permitted. MRA limits are set for forage species, target species relegated to bycatch status, and other species groups relegated to bycatch status. The species or species group in question may be retained up to a level determined by its individual MRA. MRA serves as a management tool that limits the rate of removal of forage species and prohibited species, and slows the rate of harvest of a target species and other species once TAC quotas have been reached or are being approached.

Time/Area/Gear Restrictions

Closure of areas and seasons to fishing for some or all gear types has been an effective method for reducing bycatch since the 1970's when foreign fleets were first forbidden to fish in areas of high halibut and crab concentrations. Historically, area and seasonal closures have been implemented for selected members of the prohibited species category. Management measures have included the establishment of savings areas for herring, chinook salmon, chum salmon, and king crab, as well as permanent closures to protect crab stocks in the nearshore areas of Bristol Bay and around Kodiak Island. BSAI Amendment 57 permanently prohibits the use of non-pelagic trawl gear in the BSAI pollock fishery. Trawl gear is prohibited in the southeast portion of the GOA.

Gear Modifications

Modifications in gear construction and general application can also contribute to lowering bycatch. Minimum mesh sizes allow for escapement of juvenile fishes that would otherwise be taken as bycatch. However, in some cases, this may principally result in one type of bycatch (discards) being replaced with another (unobserved fishing mortality) which is much more difficult to monitor. Biodegradable panels and halibut excluder devices are required on all groundfish pots. Management use of future gear restrictions is largely dependent on the development of technological innovations that can be applied to the fishery in a practical and cost-effective manner.

Observer Program

Observer programs provide essential technical oversight for management of the EEZ groundfish fisheries. Observers provide estimates of total catch and species composition, which allows for inseason management of the fishery. They also collect biological data for individual species that are used in stock assessments. Observers are required aboard vessels greater than or equal to 60 feet (ft) in overall length. Vessels from 60 to under 125 ft in overall length are required to have observers for 30 percent of their fishing days, and larger vessels that use pot gear have the same observer coverage requirement. Other vessels greater or equal to 125 ft are required to have one or more observers 100 percent of the time. Observers are also required at shoreside processors that process more than 500 metric tons (mt) of groundfish in any single month. Processors that process 500-1,000 mt in a monthly period require 30 percent observer coverage while those that process more than 1,000 mt require observers 100 percent of the time. Vessels and processors involved in programs that use vessel specific fishing quotas, such as the Western Alaska Community Development Quota (CDQ) program or the American Fisheries Act (AFA) pollock fisheries, have additional observer requirements which include more than one observer on some types of fishing vessels, more senior observers on some vessels, flow scales or other motion compensating scales, and certified sampling stations.

Improved Retention/improved Utilization

Responding to what was considered unacceptably high levels of bycatch, the NPFMC adopted an improved retention/improved utilization (IR/IU) program for all groundfish target fisheries. In 1997, about 260,000 mt of groundfish were discarded in the BSAI groundfish fishery, which was equivalent to about 14 percent of the total catch of TAC groundfish species. Walleye pollock, Pacific cod, and flatfish comprised approximately

87 percent of this total. In the GOA, it was estimated that pollock, cod, and flatfish represented about 76 percent of discards of TAC species. The IR/IU program required 100 percent retention of pollock and cod in the BSAI and GOA, regardless of how or where they were caught (BSAI and GOA Amendments 49). The measure has dramatically reduced the discards of pollock and cod in the groundfish fishery. In 1998, the year the amendment was implemented, discards dropped dramatically from 1997 levels. In the BSAI, pollock discards dropped from 94,800 mt to 16,200 mt, and cod discards fell from 22,100 mt to 4,300 mt. Beginning in 2003, full retention was required for rock sole and yellowfin sole in the BSAI (BSAI Amendment 49), and for all shallow water flatfish in the GOA (GOA Amendment 49). When fully implemented, retention requirements are expected to reduce overall discard rates (all species) from about 15 percent to about 5 percent.

Vessel Incentive Program

Over the years, the NPFMC has implemented a number of incentive programs designed to promote the conservation and management of groundfish fisheries. One such program is the IFQ program (BSAI Amendment 15, GOA Amendment 20) for sablefish and halibut. The program allows qualified individuals to harvest a certain percentage of the sablefish and halibut quota. Each fisherman has a quota that can be used at anytime during the open season and allows them to set their own pace. The intent of the program was to allow fishermen to become more efficient and quality conscious. Bycatch reduction was also inherent in the program. Halibut taken as bycatch in the sablefish fisheries can be retained under the yearly halibut IFQ. The source of the problem of excessive bycatch is the externalities that exist, which give fishermen the wrong incentives with respect to decisions that affect bycatch. If adequate monitoring is feasible, the externalities can be eliminated or substantially reduced and fishermen would have the incentives to minimize bycatch to the extent practicable. Eliminating the “race for fish” can decrease some of the perverse incentive fishermen currently have with respect to bycatch decisions. But additional measures can be taken to provide improved incentives to fishermen. For example, increasing the number of species for which there is accountability by individual fishing operations will address a larger number of externalities and result in, from the National perspective, better bycatch decisions by fishermen for a broader range of bycatch species.

The voluntary Salmon Donation Program (BSAI Amendment 26, GOA Amendment 29) authorizes the distribution of Pacific salmon taken as bycatch to economically disadvantaged individuals through a sanctioned distributor. Most salmon taken as bycatch are dead when brought on board the fishing vessel. Under PSC designation they must be returned to the sea, which is wasteful. The Salmon Donation Program permits the retention of this fish for the foodbank program. While the program does not reduce bycatch, it is effective at reducing bycatch waste. FMP Amendments 50 for the BSAI and GOA expanded this program to include halibut.

Experimental Fishing Permits

BSAI Amendment 17 and GOA Amendment 22 authorized the issuing of experimental fishing permits (EFPs) to persons for the purpose of obtaining information necessary to promote fishery conservation and the management of fisheries.

Record Keeping

Permitted catcher vessels equal to or greater than 60 ft in overall length must maintain a daily fishing logbook regarding fishing activity and location (50 CFR 679.50). Catcher processor vessels, motherships, shoreside processors and purchasing stations must maintain daily cumulative production logbooks that record information on fishing activity, haul receipt, production, and discards. Information on groundfish harvest, discard, receipt, and production are reported to NOAA Fisheries. Some of this data is used by the agency to manage groundfish and prohibited species quotas.

Section 4 Policy Alternatives and Rationale

All four of the alternatives under consideration by the NPFMC address the bycatch problem in the following manner.

Alternative 1 Continue under the Current Risk-Averse Management Policy: Under this alternative, the NPFMC would continue to manage the groundfish fisheries based upon the present conservative and risk-averse strategy. This strategy assumes that fishing does result in some adverse impacts to the environment and that, as these impacts become known, mitigation measures will be developed and appropriate FMP amendments will be implemented. The approach would be to continue the current strategy which relies upon management of bycatch through seasonal allocation of TAC, time and area closures, gear restrictions/modification and allocations, PSC limits, IR/IU requirements, vessel incentive programs (VIP), observer and reporting programs, and experimental or exempt fishing permits to ensure that bycatch is minimized to the extent practicable.

Alternative 2 Adopt a More Aggressive Management Policy: Under this alternative a more aggressive harvest strategy would be implemented based upon the concept that the present strategy is overly conservative and that higher harvests could be taken without threat of overfishing the target groundfish stocks. This strategy assumes that fishing at the recommended levels would have no adverse impact on the environment, except in specific cases that are documented and are known to be reoccurring. Bycatch would continue to be monitored, but PSC limits would be adjusted or eliminated. If necessary, bycatch would be managed by closures of areas to selected gear types.

Alternative 3 Adopt a More Precautionary Management Policy: This policy would seek to accelerate the existing precautionary management measures through community or rights-based management that would be extended to as many species as practicable (including a broad range of non-target species), ecosystem-based management principles and, where appropriate and practicable, increase habitat protection and impose additional bycatch constraints. Under this approach, additional conservation management measures would be taken as necessary to respond to social, economic, or conservation needs. Additional measures would be taken if scientific evidence indicated that the fishery was negatively impacting the environment, not just a population of a given species. The main elements of this alternative would include development of incentive programs for reducing the bycatch of a broad range of species, encouragement of research programs to better define population estimates and appropriate bycatch limits for non-target species, and development of management measures that would encourage the use of gear and fishing techniques that would reduce discards.

Alternative 4 Adopt a Highly Precautionary Management Policy: This policy would require that the user of the resource demonstrate that the intended use would not have a detrimental effect on the environment before significant fishing would be allowed. The strategy would be to impose very restrictive conservation and management measures that would only be modified or relaxed when additional, reliable scientific information became available. It would involve a strict interpretation of the precautionary principle. Management discussions would increase involvement of and agency responsiveness to the public, while decreased emphasis would be placed on industry and community concerns, and more emphasis would be placed on ecosystem concerns and principles, including the identification and incorporation of non-consumptive use values. The overall premise is that fishing does produce adverse impacts on the environment, but due to a lack of information and uncertainty, we know little about these impacts. With regards to bycatch, this alternative would require that bycatch mortality would be included in TAC-accounting for all target, non-target and PSC bycatch species, including unobserved fishing mortality; bycatch and PSC limits would be reduced (e.g., by

10 percent per year for five years); fisheries having greater than 25 percent bycatch rates would be phased out; PSC limits would be established for salmon, crab and herring in the GOA; and that stringent bycatch limits would be imposed for vulnerable, non-target species. This strategy would greatly curtail the regional groundfish fisheries until more information was obtained about the frequency and intensity of fishing impacts on the environment.

Each of the three alternatives to the Alternative 1 (status quo) contain two endpoints, which represent the limits of fishery management measures within each alternative. These endpoints, referred to hereafter as FMP bookends, are not intended to be stand alone alternatives, but are instead examples of the management options within an alternative. For example, Alternative 2 contains FMP bookends 2.1 and 2.2, which presents a range of different possible management tools that NPFMC could use to implement the measures defined in Alternative 2. These FMP bookends also discuss predictions of the range of potential environmental effects from the use of these management tools. This alternative structure recognizes and accounts for the fact that the resource being managed, as well as the marine ecosystem, is quite dynamic in nature and only partially understood. The process of examining a range of management tools and their potential effects for each policy alternative is an attempt to take into account the dynamic nature of the fisheries as a whole and to provide enough management regime flexibility in each alternative to allow the decision-makers to base decisions on the best available science. Specific illustrative FMP measures for each alternative are summarized in Table 3.

Table 3. Comparative Fishery Management Plan frameworks of the four alternatives dealing with bycatch.

	Alternative 1	Alternative 2		Alternative 3		Alternative 4	
	Fishery Management Plan (FMP) 1	FMP 2.1	FMP 2.2	FMP 3.1	FMP 3.2	FMP 4.1	FMP 4.2
Bycatch and incidental catch restrictions	Prohibited species catch (PSC) limits for herring, crab, halibut and salmon in Bering Sea and Aleutian Islands (BSAI), and for halibut in Gulf of Alaska (GOA).	Eliminate PSC limits.	PSC limits as for FMP 1. Where sufficient stock status information is available, adjustable PSC limits established based on a percentage of the annual stock status.	BSAI: Reduce PSC limits for herring, crab, halibut and salmon to the extent practicable (0-10%). GOA: Establish PSC limits on salmon not to exceed (NTE) a 25,000 fish cap for chinook and a 20,500 fish cap for other salmon; establish PSC limits on crab and herring based on biomass or other fishery data. Reduce GOA halibut PSC limit 0-10% for those PSC species where annual population estimates exist, the Team will explore a mortality rate-based approach to setting limits.	BSAI: Reduce PSC limits for herring, crab, halibut and salmon to the extent practicable (10-30%). GOA: Establish PSC limits on salmon NTE a 25,000 fish cap for chinook and a 20,500 fish cap for other salmon; establish PSC limits on crab and herring based on biomass or other fishery data; reduce all by 0-10%. Reduce GOA halibut PSC limit 10-30%. For those PSC species where annual population estimates exist, the Team will explore a mortality rate-based approach to setting limits.	BSAI: Reduce PSC limits for herring, crab, salmon, halibut by 30-50%. GOA: Establish PSC limits on salmon NTE a 25,000 fish cap for chinook and a 20,500 fish cap for other salmon; establish PSC limits on crab and herring based on biomass or other fishery data; reduce all by 30-50%. For those PSC species where annual population estimates exist, the Team will explore a mortality rate-based approach to setting limits.	Prohibition on all fishing pending review.
	Improved retention/improved utilization (IR/IU) for pollock, P. cod.	Repeat IR/IU	No changes from FMP 1.	No changes from FMP 1.	No changes from FMP 1.	Extend IR/IU to all target species.	Prohibition on all fishing pending review.
	Current bycatch and incidental catch restrictions. Vessel incentive program (VIP). Demersal Shelf Rockfish full-retention.	No bycatch restrictions.	Same as 2.1.	Review effectiveness of coop-managed PSC reduction. Repeal VIP program. Control bycatch by closing hotspot areas when bycatch limits are attained.	Incentive program for incidental catch and bycatch reduction, e.g.: (a) Individual Bycatch Quota (b) Harvest Priority (10% of total allowable catch (TAC) reserved to reward clean fishing) (c) Bycatch reduction standards established (d) Coop managed Harvest Priority (0-10% TAC or PSC reserved to reward clean fishing) (e) Halibut Mortality Avoidance Program (HMAP).	Reduce bycatch: BSAI: reduce all by 30-50%. GOA: reduce all by 30-50%. Bycatch limits for non-target stocks as information becomes available.	Prohibition on all fishing pending review. Prohibition on all fishing pending review.
	Crab trawl closures Cook Inlet prohibition for bottom trawl.	Eliminate all closure areas and no Cook Inlet trawl ban.	No changes from FMP 1.	No changes from FMP 1.	Develop appropriate closure areas in GOA to address bycatch for halibut and/or crab.	Establish gear closure areas and marine reserves to reduce and avoid bycatch.	Prohibition on all fishing pending review.
	Inseason bycatch, management measures: (a) establishment of fishing seasons for bycatch mgmt (b) herring closures for areas (not fishery)	Eliminate all inseason bycatch measures.	No changes from FMP 1.	No changes from FMP 1.	Repeal maximum retainable amounts (MRAs) and establish a system of caps and quotas.	No changes from FMP 1.	No inseason mgmt measures. Prohibition on all fishing pending review.

Table 3 (cont.). Comparative Fishery Management Plan frameworks of the four alternatives dealing with bycatch.

	Alternative 1	Alternative 2		Alternative 3		Alternative 4	
	Fishery Management Plan (FMP) 1	FMP 2.1	FMP 2.2	FMP 3.1	FMP 3.2	FMP 4.1	FMP 4.2
Gear restrictions and allocations	Retain existing no-trawl zones and fixed gear restrictions; Bottom trawl ban in BSAI for pollock.	Eliminate all trawl closure areas and trawl and fixed gear restrictions.	No changes from FMP 1.	BSAI prohibition on bottom trawl for pollock.	BSAI and GOA prohibition on bottom trawl for pollock.	Prohibit trawling in all fisheries that can be prosecuted with other gear types (e.g., fisheries with > 25% bycatch).	Prohibition on all fishing pending review.
	No pot fishing in GOA for sablefish.	No changes from FMP 1	No changes from FMP 1.	No changes from FMP 1.	Restrict fishing to areas where fishing has previously been concentrated.	Restrict bottom trawling for flatfish to specific areas: No trawling in areas identified (previous) as marine protected areas (MPAs).	Prohibition on all fishing pending review.
	Retain existing gear restrictions and allocations	No changes from FMP 1	No changes from FMP 1.	No changes from FMP 1.	No changes from FMP 1.		
	Sablefish and Pacific cod allocated by gear in BSAI; sablefish allocated by gear in GOA	No changes from FMP 1	No changes from FMP 1.	No changes from FMP 1.	No changes from FMP 1.	See Gear Restrictions and Allocations above.	Prohibition on all fishing pending review.
Observer program	Fixed 0/30/100% coverage.	Repeal all observer programs except American Fisheries Act (AFA) and community development quota (CDQ).	No changes from FMP 1.	Observer coverage same as FMP 1 or modified based on data and compliance needs, and should be scientifically-based.	Extend to 100% > 60' CDQ & AFA to stay the same as FMP 1.	Expand level of observer coverage.	Prohibition on all fishing pending review.
	100% for AFA & CDQ catcher boats > 60 feet (ft) and 200% for AFA & CDQ catcher processors and motherships.			e.g., random placement, flexibility, variable rate.	(a) 100% coverage on vessels (vessels less than 60' = 30% coverage) (b) 100% hauls are observed.		

Section 5 Alternative 1: Continue Under the Current Risk-Averse Management Policy

Many of the management strategies established by the NPFMC to reduce bycatch in the North Pacific groundfish fishery have centered on prohibited species and more recently target species and forage fish species. Thirty-four BSAI and 20 GOA FMP amendments have been implemented in the past 20 years to control bycatch and associated mortality within these groups. Regulatory measures have established or modified bycatch limits, fishing seasons, gear restrictions and allocations, time and area closures, bycatch rate standards, record keeping and reporting incentive programs, retention/utilization requirements, retention restrictions or prohibitions, and observer requirements. A few of these restrictions are applied to target and other species once their seasonal TACs have been reached or exceeded. The direct effect of Alternative 1 provisions on the different species groups and management tools are detailed below.

5.1 Target Species

The TACs of target species are rigorously managed by the NPFMC and NOAA Fisheries under an elaborate system of data collection, inseason management, and stock assessments. Target species are subject to retention limits once the seasonal TAC quota has been met or is being approached. Thereafter, the species cannot be targeted but may be retained up to an MRA determined by the NPFMC. If the harvest of a given target species on bycatch status approaches the acceptable biological catch (ABC), that species is put on prohibited species status, which bans the retention of that species for the remainder of the year. Bycatch status effectively slows the rate of harvest of the TAC species in question once the TAC has been reached or is being approached. In 2002, the only groundfish fisheries for which seasonal TAC was reached were pollock and Alaska plaice in the BSAI (Table 4). The only other fishery for which harvests came within 5 percent of the seasonal TAC was sablefish in the GOA.

5.2 Prohibited Species

Pacific Halibut

Pacific halibut fisheries are managed by a treaty between the United States and Canada through recommendations by the International Pacific Halibut Commission (IPHC). Stock assessments conducted by the IPHC take into account all halibut removals, including bycatch in the groundfish fisheries. Catch and discard mortality data are provided by observers associated with the groundfishing fleet. Stock assessments are then used to allocate harvest quotas in the directed halibut fishery. Because IPHC stock management accounts for bycatch mortality, halibut quotas in the directed fishery compensate for bycatch in the groundfish fisheries. The halibut resource is considered quite healthy and directed harvests in recent years have been near record levels.

Halibut bycatch is controlled in the BSAI groundfish fishery using PSC limits applied to specific target fisheries. Unlike other PSC limits, which allocate total allowable bycatch, PSC limits for halibut bycatch are for mortalities only. Halibut returned live to the sea do not accrue toward the PSC limit. Most halibut taken as bycatch are juveniles, so the loss must be viewed not just as immediate tonnage, but also as fish that would have grown larger.

For the 2003 fishing season, total halibut PSC limits have been set at 3,675 mt for trawl and 900 mt for nontrawl fisheries (Table 5). Bycatch limits are apportioned by gear type and target species, and within target species, they are further apportioned by season. For example, 26 percent of the 2003 halibut PSC limit assessed to trawl fisheries operating in the BSAI was allocated to yellowfin sole. This 26 percent is further sub-allocated among four fishing seasons. Halibut bycatch allocations essentially direct fisheries, by area or time, to regions where the highest volume or highest value target species may be harvested with minimal halibut bycatch. When any fishery exceeds its seasonal limit, the entire Bering Sea is closed for that fishery.

Table 4. Total allowable catch allocations and groundfish harvests (metric tons) by target species for the 2002 fishing season.

Target fishery	2002		Percent of TAC
	Total allowable catch (TAC)	Catch	
BSAI			
Pollock	1,486,100	1,486,006	100.0
Pacific cod	200,000	184,937	92.5
Atka mackerel	98,000	87,986	89.8
Yellowfin sole	86,000	74,861	87.0
Rock sole	54,000	41,621	77.1
Other species	30,825	26,467	85.9
Pacific Ocean perch	30,600	22,392	73.2
Flathead sole	25,000	15,419	61.7
Greenland turbot	16,000	5,506	34.4
Arrowtooth flounder	16,000	4,010	25.1
Alaska plaice	12,000	12,291	102.4
Northern rockfish	6,760	4,010	59.3
Sablefish	4,480	1,887	42.1
Other flatfish	3,000	2,628	87.6
Squid	1,970	784	39.8
Other rockfish	1,037	946	91.2
Shortraker/rougheye rockfish	1,028	573	55.7
GOA			
Pollock	58,250	50,390	86.5
Pacific cod	44,230	40,524	91.6
Arrowtooth flounder	38,000	20,941	55.1
Shallow water flatfish	20,420	6,842	33.5
Pacific Ocean perch	13,190	11,735	89.0
Sablefish	12,820	12,246	95.5
Other species	11,330	3,748	33.1
Rex sole	9,470	3,009	31.8
Flathead sole	9,280	2,108	22.7
Pelagic shelf rockfish	5,490	3,318	60.4
Northern rockfish	4,980	3,335	67.0
Deepwater flatfish	4,880	558	11.4
Thornyhead rockfish	1,990	1,125	56.5
Shortraker/rougheye rockfish	1,620	1,291	79.7
Other slope rockfish	990	771	77.9
Atka mackerel	600	84	14.0
Demersal rockfish	350	182	52.0

Table 5. Prohibited species catch allocations for the Bering Sea and Aleutian Islands Fishery Management Unit, 2003. Projected crab populations are denoted parenthetically.

Species	Gear	Prohibited species catch (PSC) limits	Fishery	Season allowances
Halibut	Trawl	3,675 metric tons (mt) (mortality)	<u>Trawl</u> Yellowfin sole [24%]	1/20 to 3/31 [30%] 4/1 to 5/20 [22%]
	Non-trawl	900 mt (mortality)	N/A	5/21 to 7/3 [6%] 7/14 to 12/31 [43%]
	Pot gear	exempt	Rocksole, other flatfish, flathead sole [21%]	1/20 to 3/31 [58%] 4/1 to 7/3 [21%] 7/4 to 12/31 [21%]
	Jig gear	exempt	Turbot, sablefish, arrowtooth [0%] Rockfish [2%]	None 7/4 to 12/31 [100%]
	Hook-and-line (sablefish only)	exempt	Pacific cod [39%] Pollock, Atka mackerel, other [6%] Community development quota (CDQ) fisheries [7%]	None None None
			<u>Non-trawl</u> Pacific cod [86%] Other non-trawl [6%] CDQ Fisheries [7%]	1/1 to 6/10 [41%] 8/15 to 12/31 [59%] None
Herring	Trawl	1,526 mt (1% of estimated biomass)	Yellowfin sole [9%] Rocksole, other flatfish, flathead sole [1%] Turbot, sablefish, arrowtooth [<1%] Rockfish [<1%] Pacific cod [1%] Pollock, Atka mackerel, other [87%]	None
Red king crab (zone 1)	Trawl	97,000 crabs	Yellowfin sole [17%] Rocksole, other flatfish, flathead sole [62%] Pacific cod [12%] Pollock, Atka mackerel, other [2%] CDQ Fisheries [8%]	None

Table 5 (cont.). Prohibited species catch allocations for the Bering Sea and Aleutian Islands Fishery Management Unit, 2003. Projected crab populations are denoted parenthetically.

Species	Gear	Prohibited species catch (PSC) limits	Fishery	Season allowances
Opilio Tanner crab (Bycatch limitation zone)	Trawl	4,350,000 crabs	Yellowfin sole [64%] Rocksole, other flatfish, flathead sole [22%] Turbot, sablefish, arrowtooth [1%] Rockfish [1%] Pacific cod [3%] Pollock, Atka mackerel, other [2%] CDQ Fisheries [8%]	None
Bairdi Tanner crab (zone 1)	Trawl	980,000 crabs	Yellowfin sole [35%] Rocksole, other flatfish, flathead sole [37%] Pacific cod [19%] Pollock, Atka mackerel, other [2%] CDQ Fisheries [8%]	None
Bairdi Tanner crab (zone 2)	Trawl	2,970,000 crabs	Yellowfin sole [60%] Rocksole, other flatfish, flathead sole [20%] Rockfish [<1%] Pacific cod [11%] Pollock, Atka mackerel, other [1%] CDQ Fisheries [8%]	None
Chinook salmon	Trawl	29,000 fish		1/1 to 4/15
Other salmon	Trawl	42,000 fish		8/15 to 10/14

Source: DiCosimo (2002).

In recent years halibut PSC limits for the GOA have been 2,000 mt for trawl and 300 mt for nontrawl fisheries. PSC limits in the GOA may also be allocated by season, among fisheries, and among gear types. If some gear types have excessively high bycatch mortality rates, the NPFMC may withhold that fishery's halibut PSC limit in order to promote other gear types that might otherwise close prematurely. In both the BSAI and GOA, bycatch limits of Pacific halibut often prevent the annual TAC of many groundfish species from being harvested.

Other measures that have reduced halibut bycatch include seasonal and area allocations of TAC for selected target species, seasonal and year-round area closures, gear restrictions, careful release requirements, an IFQ VIP, public reporting of individual bycatch rates, and gear modifications. Examples of gear modifications include biodegradable panels and halibut excluder devices that are required on all groundfish pots. Implementation of the IFQ program (see Management Tools, Section 3.2) resulted in an immediate reduction in annual PSC limits for the GOA from 750 mt to 150 mt.

Pacific Herring

Directed fisheries for herring occur entirely in state waters and are managed by the Alaska Department of Fish and Game (ADF&G). Harvest quotas are determined by the Alaska Board of Fisheries and are based upon biomass forecasts as determined from landings data. Pacific herring bycatch limits (BSAI Amendment 16a) in the groundfish fisheries apply to trawl gear operating within three specified areas designated as Herring Savings Areas 1, 2, and 3, all of which are located in the Bering Sea (Figure 1). These areas are characterized by large seasonal aggregations of herring. The annual PSC limit determined by the NPFMC is set at 1 percent of projected herring biomass and is designed to fluctuate with herring abundance as estimated for each year. For the 2003 fishing season, the herring PSC limit has been set at 1,526 mt (Table 5). This bycatch limit is also apportioned among specified trawl fisheries. If a bycatch allowance is attained for a specific fishery, that fishery is prohibited from operating in Area 1 from June 15 to July 1, in Area 2 from July 1 to August 15, and in Area 3 from September 1 through March 1. These time/area closures are designed to track seasonal herring migrations and aggregations. In the BSAI, herring bycatch occurs primarily in the pollock and yellowfin sole fisheries.

In the GOA, bycatch is rather nominal and occurs almost exclusively in the pollock fisheries; 78 percent in pelagic trawls and 12 percent in bottom trawls. Herring bycatch is estimated to be such a small percentage of total herring biomass in the GOA that there are no PSC limits or area closures designated by the NPFMC.

King and Tanner Crabs

Many of the crab stocks in the BSAI are currently at or below critical levels. The Bristol Bay red king crab population is below critical stock size and the directed fishery was closed in 1994 because of depressed populations. Conditions were so dire that a red king crab savings area was established by emergency rule in 1995, and made permanent under BSAI Amendment 37. The blue king crab population in the Pribilof Islands is considered to be low (NMFS 1998d) and population in the Saint Matthew Island area is estimated to be below minimum stock size threshold (NMFS 1999b). The stock was declared overfished and the fishery was closed in 1999. The NPFMC considers the Bering Sea Tanner crab stock overfished and is likely that the population will continue to decline for years (Morrison *et al.* 1998).

In response to the depressed status of many crab stocks, the NPFMC established permanent year-round closures in areas deemed to be critical crab habitat (Figures 2 and 3). These include the 19,000 square nautical miles (nm²) nearshore Bristol Bay area (BSAI Amendment 37), the 7,000 nm² Pribilof Island Habitat Conservation Area (BSAI Amendment 21a), the 4,000 nm² Red King Crab Savings Area (BSAI Amendment 37), the 1,000 nm² Red King Crab Protection Area around Kodiak Island (GOA Amendment 26), and Management Area 512 closure (BSAI Amendment 10). In 2000, the NPFMC approved Amendment 60 which permanently prohibits nonpelagic trawling in a 7,000 nm² area of Cook Inlet that is considered critical habitat for depressed king and Tanner crab stocks.

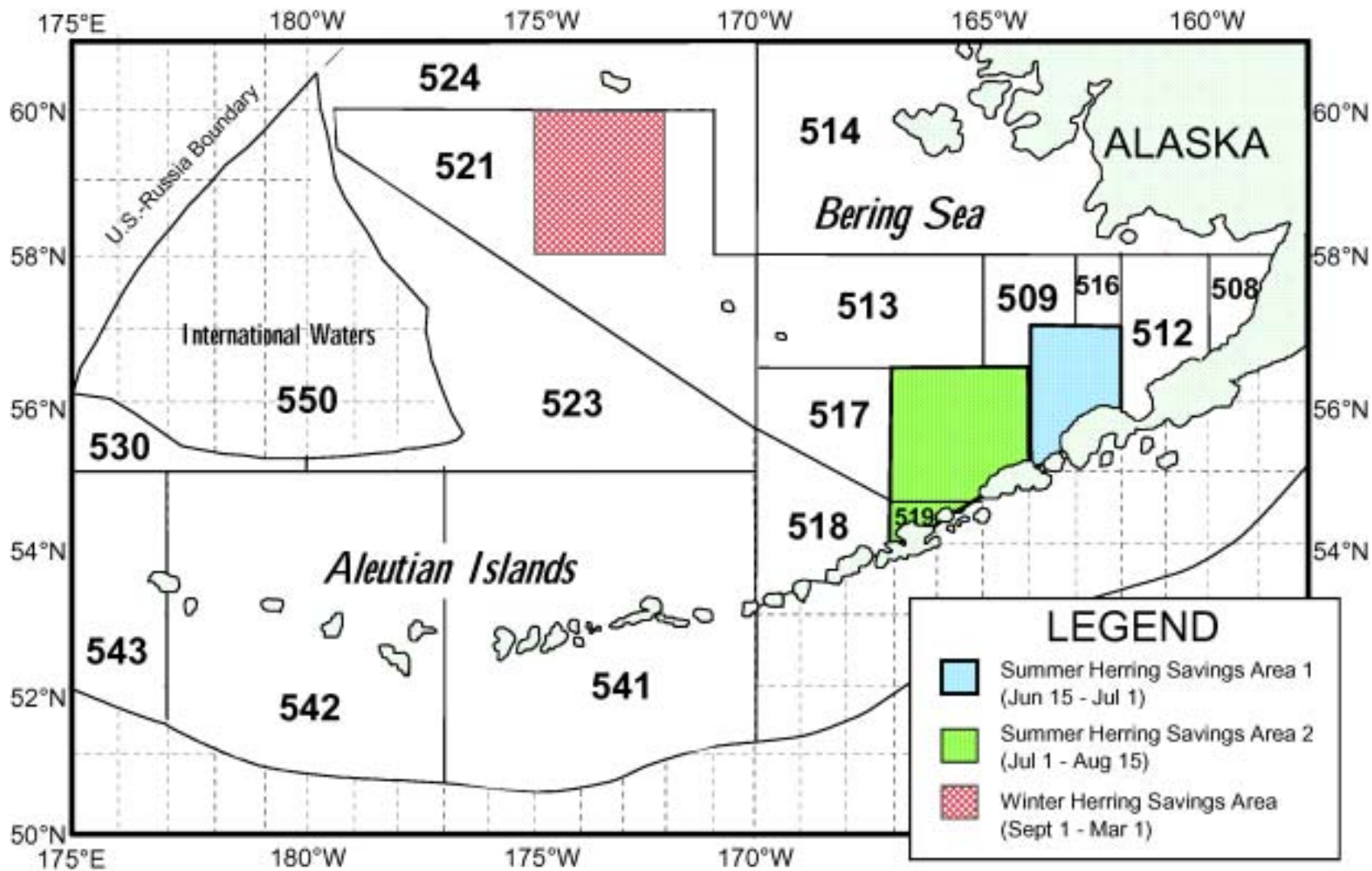


Figure 1. Designated Pacific herring savings areas.

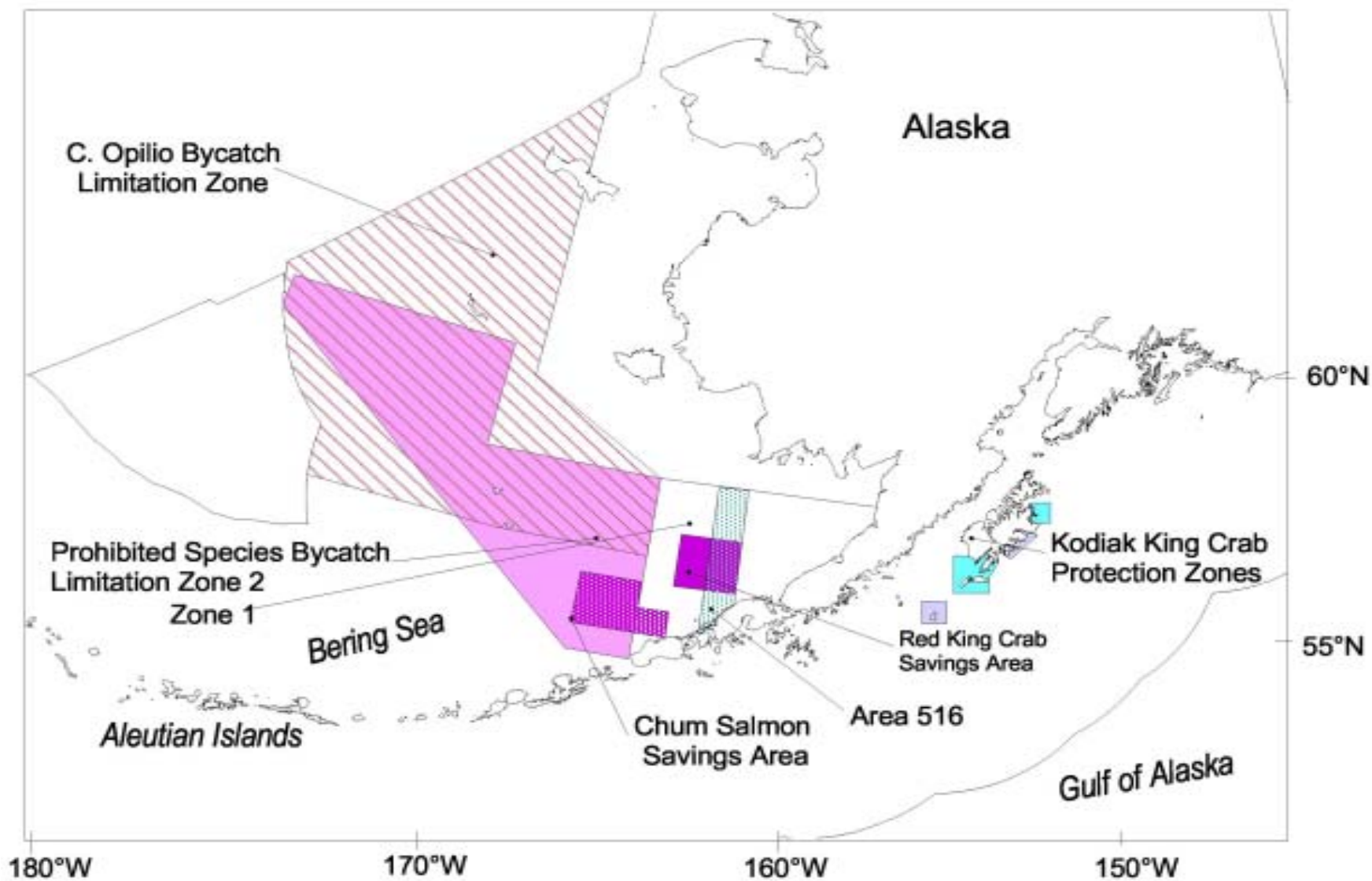


Figure 2. Management areas involving prohibited species in the Bering Sea and Gulf of Alaska. Source: NMFS.

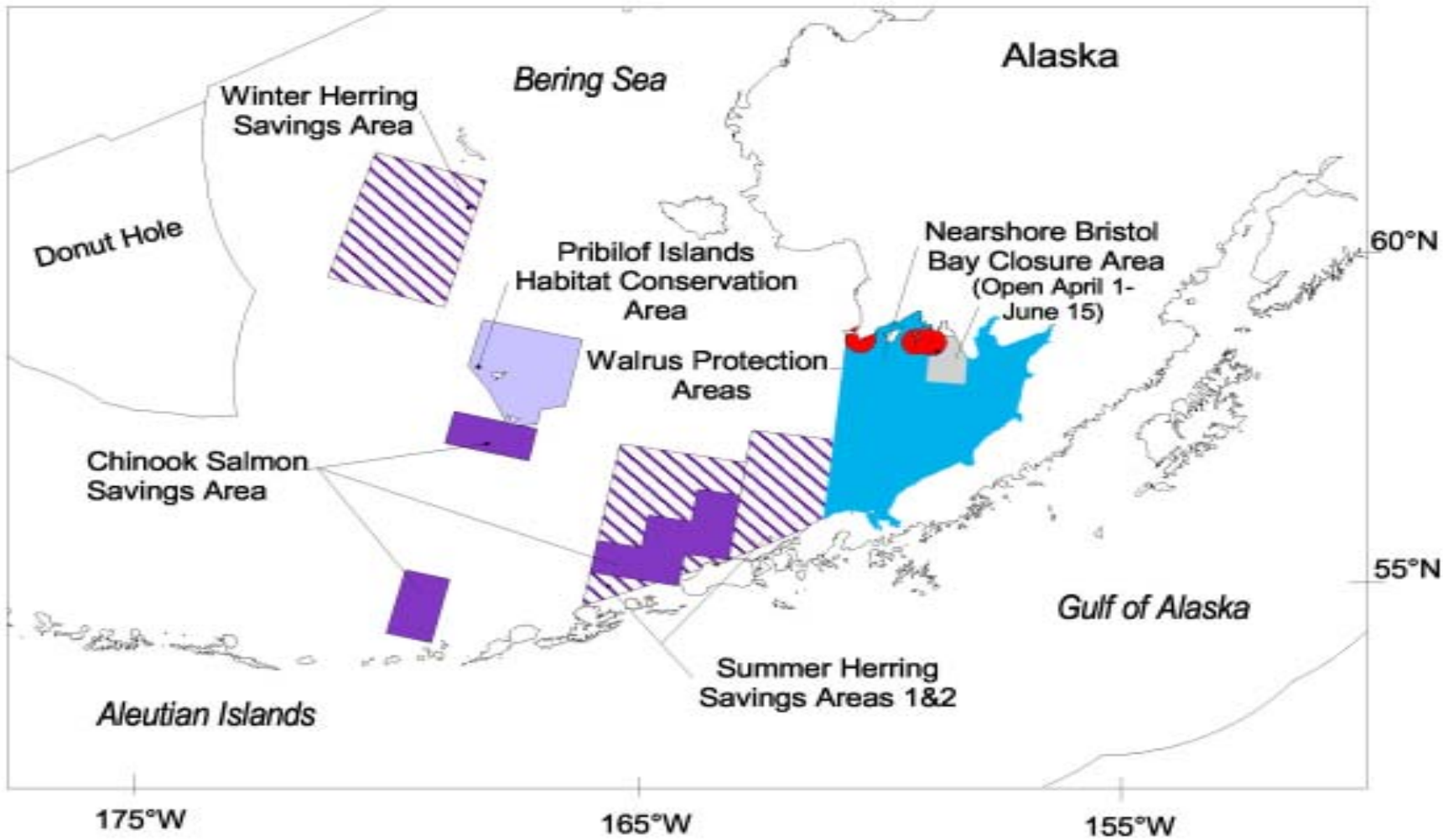


Figure 3. Management areas involving prohibited species and walrus in the Bering Sea. Source: NMFS.

Crab bycatch in the BSAI is also managed through the use of seasonal time and area closures and PSC limits (BSAI Amendments 40 and 41). Bycatch limits for king and Tanner crabs are generally a function of crab abundance as estimated from annual trawl surveys conducted by NOAA Fisheries (Table 6). Current PSC limits represent about 1 percent or less of the estimated annual abundance of each species. This fixed percentage approach means that annual PSC limits adjust in conjunction with increases or decreases in the underlying population. Bycatch limits are considered an acceptable loss rate that does not significantly deplete stocks or impede the recovery rates for rebuilding depleted stocks. BSAI Amendment 57, which prohibits the use of non-pelagic trawl gear in the BSAI pollock fishery, further reduces crabs bycatch limits as indicated in Table 5. PSC limits are also allocated among areas and target fisheries. When a PSC limit is reached for a specific fishery/zone, that fishery is closed in that zone for the season. Most of the bycatch of crabs in the BSAI comes from directed trawl fisheries for yellowfin sole, rock sole, flathead sole, and Pacific cod.

Table 6. Prohibited species bycatch limits for crabs in the Bering Sea and Aleutian Islands.

Species	Prohibited species catch (PSC) limits	Abundance
Red king crab (Zone 1)	35,000 crabs (-3,000 additional crabs)	Less than 14.5 million pounds of female Spawning biomass in eastern Bering Sea
	100,000 crabs (-3,000 additional crabs)	From 14.5 to 55 million lbs of female spawning biomass in eastern Bering Sea
	200,000 crabs (-3,000 additional crabs)	Greater than 55 million lbs of female spawning biomass in eastern Bering Sea
Opilio Tanner crab Bycatch Limitation Zone	0.1133% of total crab abundance (-150,000 additional crabs)	Minimum: 4.5 million crabs Maximum: 13 million crabs
Bairdi Tanner crab (Zones 1 and 2)	Zone 1 (-20,000 additional crabs)	
	0.5% of abundance	0-150 million crabs
	750,000 crabs	150-270 million crabs
	850,000 crabs	270-400 million crabs
	1,000,000 crabs	Over 400 million crabs
	Zone 2 (-30,000 additional crabs)	
	1.2% of abundance	0-175 million crabs
	2,100,000 crabs	175-290 million crabs
	2,550,000 crabs	290-400 million crabs
	3,000,000 crabs	Over 400 million crabs

There are no PSC limits or time and area closures for crabs in the GOA. Although the bycatch of crabs in the GOA is very small relative to those in the BSAI, there is little information regarding the sizes and status of GOA stocks. Without such information, there is no way to determine the proportion of each stock being affected by bycatch or if critical crab habitat is being damaged.

Of the two principal management tools used to control crab bycatch -PSC limits and time/area closures- PSC limits are probably less effective in terms of decreasing the adverse effects of the BSAI groundfish fishery with respect to the crab stocks. Crab bycatch in the trawl fishery is not a major source of crab mortality, relative to other sources of crab mortality such as the directed crab fishery. However, because trawling negatively impacts crab stocks through unobserved mortality and habitat degradation, closed areas tend to be more effective than PSC limits in reducing the impact of trawling on crab stocks (Witherell and Harrington 1996). The critical importance of crab habitat to the success of crab populations was the key element that prompted the NPFMC to establish crab savings and conservation areas. These protected areas likely have a significantly beneficial effect on the conservation of crab stocks in the BSAI.

Pacific Salmon

Pacific salmon and trout fisheries are managed under a combination of domestic and international regulations and treaties. Fisheries are managed by ADF&G within state waters, where most of Alaska's commercial fishing occurs. Commercial fishing within the EEZ is limited to southeast Alaska and NPFMC management is deferred to ADF&G. Harvests of chinook, coho, and sockeye salmon in southeast Alaska are managed by agreement with Canada under the Pacific Salmon Treaty. Management of salmon fisheries in international waters of the Northern Pacific is under the auspices of the North Pacific Anadromous Fish Commission, which consists of a four countries (Canada, Japan, Russia, and the U.S.).

Within the State of Alaska, ADF&G manages salmon stocks for individual rivers of origin based upon escapement (the number of surviving spawners). Most salmon return to their natal rivers of origin to spawn and this fidelity leads to reproductively distinct stocks within the overall population. Each year, spawners are counted during their upstream migration. This means that escapement estimates are made after stocks have been reduced by natural mortality at sea, bycatch at sea, and directed fisheries downriver. If the perceived number of surviving spawners in a given river is below management goals, ADF&G limits or prohibits fishing in Alaska's commercial, subsistence, and recreational fisheries. Stock management by the state thus compensates for salmon bycatch in the groundfish fishery by reducing yields to directed salmon fisheries.

The five species of Pacific salmon are divided into two FMP bycatch management groups: chinook salmon, and "other" salmon (chum, sockeye, coho, pink). Steelhead trout have not been observed recently in either the BSAI or GOA and are not considered in this assessment. All groundfish fisheries in the BSAI and GOA are prohibited from retaining any species of salmon except for those retained under the Voluntary Salmon Donations Permit that authorizes their retention for local food banks (BSAI Amendment 26, GOA Amendment 29). In 1999, over 3 million pounds were donated.

Of the five salmon species, only the bycatch of chinook and chum salmon are of any serious concern in the BSAI and GOA. Pink, coho, and sockeye salmon populations in Alaska are considered healthy and bycatch in the groundfish fisheries represents only a minuscule portion of state harvests. These three species also are small components of bycatch in the groundfish fishery relative to chinook and chum salmon. The 926,879 Pacific salmon taken as bycatch in the BSAI from 1990 to 1997 consisted of 590,892 (64 percent) chum salmon, 331,759 (35 percent) chinook salmon, 3,557 (0.38 percent) coho salmon, 173 (0.02 percent) sockeye salmon, and 491 (0.05 percent) pink salmon. The 366,491 Pacific salmon taken as bycatch in the GOA from 1990 to 1997 consisted of 200,637 (55 percent) chum salmon, 160,264 (44 percent) chinook salmon, 3,952 (1.08 percent) coho salmon, 337 (0.09 percent) sockeye salmon, and 1,301 (0.35 percent) pink salmon. Most of these salmon are taken in pelagic trawl gear targeting pollock.

Although the overall bycatch of chinook and chum salmon is also very small relative to state harvests, bycatch take could pose a threat to specific stocks (rivers of origin). Some western stocks of chinook salmon are currently depressed. In 2000, there were fishing closures in the Yukon and Kuskokwim river systems and it is possible that ADF&G escapement goals may not be realized over the immediate future. If individual stocks become so depressed that full closure of direct fisheries is insufficient to enable a rebound in the population, then any additional mortality, including bycatch, could negatively impact the stock. It is estimated that 58-70 percent of chinook salmon bycatch in the BSAI groundfish fisheries may originate from western Alaska stocks, but it is unknown what proportion of these salmon are specifically from depressed stocks.

Analysts contend that there is insufficient information to determine the effects of BSAI bycatch and PSC limits on specific at-risk stocks within this western group.

The NPFMC adopted BSAI Amendment 21b, which established a PSC limit in the BSAI of 48,000 chinook salmon allocated between January 1 and April 15 for trawl gear. Upon attainment of the bycatch limit, all trawling was prohibited in the 9,000 nm² Chinook Salmon Savings Area (Figure 3). Chinook salmon bycatch tends to be high in this area during the January-April time frame. Trawl fisheries were reopened after April 16 for the remainder of the year. The PSC limit represents about 19.2 to 36.9 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chinook salmon landings reported between 1997 and 1999. This is a substantial portion of the domestic harvest.

In 1999, the NPFMC adopted BSAI Amendment 58, which: 1) further reduced the chinook salmon bycatch limit from 48,000 to 29,000 fish by 2003, 2) implemented year-round accounting of chinook salmon bycatch in the pollock fishery, 3) revised the boundaries of the Chinook Salmon Savings Areas, and 4) set more restrictive closure dates. This reduced PSC limit represents about 11.6 to 22.3 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chinook salmon landings reported between 1997 and 1999. Still a sizable proportion of the domestic harvest.

PSC limits have not been established for salmon in the GOA, however, seasonal fishing seasons for pollock in the central and western GOA have been adjusted to avoid periods of high chinook and chum salmon bycatch. Bycatch in the GOA groundfish fishery is presently only about 2-4 percent of directed chinook salmon landings in Alaska and is not likely have an effect on populations in general. Western stocks are thought to make up a smaller proportion of chinook salmon bycatch than in the BSAI, however, there is insufficient information to determine how much smaller and what proportion may actually consist of specific at-risk stocks.

Some western Alaska stocks of chum salmon are also depressed. In the BSAI (BSAI Amendment 35), a limit of 42,000 "other" salmon (primarily chum salmon) can be taken between August 1 and September 1 in the 5,000 nm² Chum Salmon Savings Area (Figure 2). Analysts estimate that about 19 percent of chum salmon bycatch in the BSAI is from western stocks. Because this is equivalent to only 1.3 to 1.5 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999, bycatch represents a tiny fraction of landings even for depressed stocks. In all likelihood, bycatch of chum salmon in the BSAI has a negligible effect on Alaskan stocks. Further, there is considerable spatial overlap of the Chum Salmon Savings Area with the Steller Sea Lion Conservation Area (SCA), which, under provisions of the AFA, greatly limits pollock fishing in that region of the Aleutian Islands.

There are currently no bycatch limits or area closures for "other" salmon in the GOA. From 1997 to 1999, chum salmon comprised about 56 percent (5,000 fish) of "other" salmon taken as bycatch in the GOA. This amount of bycatch was equivalent to 0.02-0.03 percent of all chum salmon landings and only 0.34-0.82 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999. Such low proportions suggest that chum salmon bycatch in the GOA will have little impact on any Alaskan stocks.

Although there are no salmon stocks in Alaska that are listed as either endangered or threatened under the Endangered Species Act (ESA), there are several listed stocks of chinook and chum salmon from rivers in Washington, Oregon, and California that could migrate into marine waters off Alaska. After detailed study, NMFS (1994) concluded, "the groundfish fisheries are not likely to jeopardize the continued existence of any ESA-listed salmon."

5.3 Forage Species

Direct fisheries for forage fish species are prohibited in the EEZ (BSAI Amendment 36, GOA Amendment 39). MRA limits are set at 2 percent for the entire group regardless of species composition. Fish taken within the 2 percent limit may be commercially retained and typically are processed into fishmeal. In all cases, most of the forage fish bycatch is taken in pelagic trawls; 74 percent in the BSAI, 93 percent in the GOA. The vast majority of forage fish taken as bycatch are osmerids (capelin, eulachon, other smelts). Collectively, forage fish form only a small part of bycatch of groundfish fisheries typically comprising less than 0.1 percent of the directed harvests. From 1990 to 1993, osmerid bycatch ranged from 127.2 to 530.7 mt in the GOA, and from 31.8 to 292.1 mt in the BSAI. In the most recent three years, 1997 to 1999, an average of 39 mt of forage species were taken annually in the BSAI and 61 mt in the GOA. Bycatch in the GOA was higher at 218 mt.

There are no biomass estimates for forage fish in the BSAI or the GOA and it is difficult to quantitatively determine the effect of bycatch on forage fish populations. For many forage fish species, little is known about their abundance, growth rates, maturity, migrations, and trophic relationships. Some of the more common forage fishes such as capelin, smelt, and eulachon are considered R-selected species, which is a term used in population analysis that refers to characteristics of a species' high reproductive rates, fast growth, and rapid maturity. These R-selected species may undergo considerable natural fluctuations in abundance. While this R-selective strategy may help stocks rebound quickly from depressed levels, variable abundance could make stock (impact) assessments that much more difficult.

Nevertheless, given the position that forage fish, particularly osmerids, occupy in the North Pacific ecosystem, it is unlikely that bycatch would have a significant effect on any of the forage fish species over time. The mere fact that forage fish play such a central role in the trophic chain, serving as food for a wide variety of fish, marine mammals, and seabirds, suggests that they must exist at biomass levels capable of sustaining such a vast biological system. Between the BSAI and GOA there are an estimated 48 million seabirds, nearly 230,000 seals and sea lions, a groundfish fishery that annually permits the harvest of 1.5-2.0 million mt of fish, a coastal halibut fishery that annually harvests nearly 40,000 mt, and an Alaskan salmon industry that in 1998, landed 154 million (330,000 mt) adult fish. The annual loss of a few hundred mt of forage fish is unlikely to have a significant effect on this system or forage fish stocks.

5.4 Other Species

Annual aggregate TAC limits are set for the group of other species, and separately for squid in the BSAI, based upon stock assessments. Based upon 1999 stock assessments, the NPFMC is considering an expanded FMP amendment that would specify TACs on individual species of sharks and skates. The NPFMC has also recommended that "other" species be placed on bycatch only status. These decisions are pending.

There is some concern that under the current management plan a species or species group could be disproportionately exploited within the aggregate TAC. The "other" species category includes species with diverse life histories, and in many cases little is known about their population dynamics and structure. Species that are long-lived and have low reproductive potential are particularly vulnerable to depletion because it takes them longer to rebound from natural and fishing mortality. In addition to the paucity of life history data, a lack of research and fishing data also hampers assessments of stock status and bycatch effects. Individual species within the skate and sculpin complexes are not identified aboard ship because of a lack of trained personnel and time constraints. This greatly limits the value of any catch data. A lack of biomass estimates for squid precludes stock status relative to bycatch. All of these data limitations make it difficult to determine the extent to which individual species are protected from the pressures of bycatch given the aggregate TAC allocation. Current NPFMC efforts to develop individual TACs and bycatch restrictions on individual taxa within the "other" species category could eventually prove beneficial to disproportionately exploited species should they exist.

5.5 Nonspecified Species

There is currently no management and only limited monitoring of the species in this category. Retention of any nonspecified species is permitted under current FMP policy. The same concerns about disproportionate exploitation of certain species expressed above for other species is also germane to nonspecified species. Little is known about the ecology of many of the species in this category and limited fishing data are recorded. For example, the bycatch of grenadiers is higher in the GOA than all species in the other species category combined, yet the extent to which this bycatch may affect these long-lived species is unknown.

5.6 Indirect Effects

5.6.1 Spatial and Temporal Concentrations in Bycatch

Indirect impacts caused by spatial or temporal concentrations of bycatch might include the overharvesting of a distinct genetic component of a stock, local alterations in predator-prey relationships, or adverse impacts to spawning grounds or aggregations. In many instances, particularly with species within other, nonspecified, and forage fish categories, so little is known about their population dynamics and life histories that it is difficult to determine the indirect impacts of the Alternative 1. The dynamic nature of the North Pacific ecosystem would make assessments equally difficult even for more well understood fish species. Assessments would have to contend with a host of variables such as natural fluctuations in population size, migratory patterns, shifts in population age structures, and localized productivity. Overall, there is insufficient information with which to assess the effects of spatial and temporal concentrations in bycatch.

5.6.2 Socioeconomic

FMP management measures have had some level of success in decreasing overall bycatch mortality, but not without cost to the groundfish fishery. Halibut bycatch mortality limits have resulted in numerous closures over the years and have reduced the commercial catch of target species. In part because of halibut PSC limits, portions of the annual TACs specified for most flatfish species have remained unharvested (Witherell 1995). Careful release requirements established for the long-line fishery have improved discard survival but have also increased the amount of time and effort expended by fishermen. Pacific herring PSC limits have repeatedly closed Herring Savings Areas 2 and 3 to trawl fisheries directed at pollock, rock sole, yellowfin sole, and other flatfishes. Area closures for salmon and crabs also impede commercial fishing efforts.

In general, many steps taken to reduce bycatch also reduce commercial harvests and/or the economic value of those harvests within the North Pacific groundfish fisheries. The extent of economic cost to the groundfish industry depends on a number of factors, the specifics of which are far beyond the scope of this overview.

Aside from promoting general conservation, protecting depressed species, and reducing waste, bycatch restrictions implemented for the groundfish industry confer positive economic benefits to nongroundfish fisheries. Regardless of the regulatory bodies involved, halibut, herring, and salmon fisheries are managed with the primary goal of maintaining healthy, productive, and sustainable populations that will support commercial, subsistence, and recreational fisheries over the long-term. Population declines systematically trigger regulatory restrictions on fishing while population expansions allow for increased harvests. Over the long-term, reductions in bycatch (mortality) in the groundfish fishery typically allow increased harvests in the other domestic fisheries. Whether the gain to domestic fisheries is substantial is a matter for more detailed economic analysis.

5.7 Cumulative Effects

The current analysis has identified three ways in which FMP policy might affect the diversity or stability of the BSAI and GOA ecosystems: 1) altering biodiversity 2) altering predator-prey relationships, and 3) altering energy flow.

5.7.1 Biodiversity

Biological diversity (or biodiversity) is a general term that defines the diversity of life and its processes (CEQ 1993). Biodiversity may be expressed in terms of species diversity, functional (trophic) diversity, or genetic diversity. Measures of species diversity include the number of species in a community (species richness) and the relative abundance among species (evenness). Functional diversity deals with the stability and relative abundance among interdependent taxa within the trophic web. Genetic diversity is the inherent genetic heterogeneity within a species. Species characterized by greater genetic diversity are generally more capable of responding and adapting to physical and biological changes in their environment. The removal of fish through bycatch could disproportionately affect one species over another thereby disrupting the natural balance in species or trophic diversities. Removal of localized spawning aggregations could alter genetic diversity if the particular aggregation of fish removed from the system is genetically different from other components of the population.

At present, there is insufficient information on the ecological and genetic diversity of fish species and benthic fauna in the BSAI and GOA to assess the cumulative effects of the alternative on biodiversity in terms of bycatch. Species characterized by long life spans, slow growth, late maturity, and/or low reproductive potential run the greatest risk of being depleted by bycatch removal. Whether the bycatch incurred under Alternative 1 is sufficient to substantially impact vulnerable species having these characteristics is unknown. Bycatch mortality is generally considered to have a negative effect because of increased loss to the ecosystem; however, the magnitude and significance of this loss cannot be accurately assessed at this time.

Factors unrelated to the groundfish fishery are far more likely to be the principal agents driving species diversity in the region. These would include the introduction of non-indigenous species, natural fluctuations in the relative abundance of species within the food web, and long-term climatic changes. The potential changes caused by global climatic changes alone could potentially dominate the system regardless of any groundfish management plan.

5.7.2 Predator-Prey Relationships

Predator-prey relationships can be altered by selectively removing predators or competing forage species from the food web, overfishing important forage species by concentrating fishing effort in time or space, removing top predators, or by introducing non-indigenous competitors into the food web. Given the natural and anthropogenic forces at work in the North Pacific, it seems unlikely that bycatch associated with Alternative 1 policy has any significant effect on the predator-prey relationships overall. The external pressures exerted directly on predator-prey components of the food web by all of the directed fisheries operating in Alaskan and North Pacific would more than overwhelm any effect of bycatch. Compared to bycatch, the removals of predator and prey biomass associated with seasonal harvests of salmon, halibut, herring, groundfish, and crabs are massive.

At a localized level, however, depletion of specific size or age groups could have short term effects on predator-prey relationships. Such impacts might be difficult to detect. Their ramifications to the ecosystem are uncertain.

5.7.3 Ecosystem Energy Balance

Fishing can remove energy (i.e., biomass) from an ecosystem. If sufficient energy is removed from or returned as discards to the system relative to total biomass, the energy balance of the system could be destabilized or changed with unknown consequences. In fact, it is likely that anthropogenically-induced changes have already occurred in the North Pacific ecosystem given the long history of commercial and subsistence fishing in the region. Nevertheless, it is highly unlikely that bycatch associated with Alternative 1 have significantly altered the energy characteristics of the BSAI and GOA. The amount of biomass being removed that is directly associated with these two components is minuscule compared to the biomass removal that results from the combined commercial, subsistence, and recreational fisheries operating in Alaska and the North Pacific. Further, the ecosystem energy balance in the North Pacific is dynamic and in a constant

state of flux in both time and space. Over time, the effect of bycatch removal and alterations of energy flow patterns associated with discarding of bycatch would be easily absorbed by such a massive oceanic system.

Section 6 **Alternative 2: Adopt a More Aggressive Management Policy**

6.1 Policy Goals and Objectives

Under this alternative a more aggressive harvest strategy would be implemented. Details of policy goals and objectives are outlined in Section 4 entitled Policy Alternatives and Rationale. Specific illustrative FMP measures for Alternative 2 are summarized in Table 3.

6.2 Direct Effects

The overall bycatch effect of Alternative 2 would be a general increase in bycatch mortality for all five species categories (e.g., target, prohibited, and forage, other, and nonspecified species). The severity of increased bycatch would depend upon the degree to which management policy would shift from Alternative 1 (FMP 2.2) toward the opposite Alternative 2 extreme (FMP 2.1). The increase in bycatch would be further exacerbated by provisions in Alternative 2 which allow for an increase in TACs for the directed fisheries from current levels (FMP 2.2) all the way up to a projected 15-20 percent increase in fishing (FMP 2.1). The gradual repeal of time and area closures across the Alternative 2 policy spectrum could increase mortality within crab, herring, salmon, and halibut populations. The direct effect of Alternative 2 provisions on the different species groups and management tools are detailed below.

6.2.1 Target Species

Normally, rigorous management of directed fisheries would allow target stocks to endure higher mortality associated with bycatch regardless of the management measures adopted within the range offered under Alternative 2. Any increase in mortality would eventually be incorporated into stock assessments that are used by the NPFMC and NOAA Fisheries to set TAC limits for subsequent fishing seasons. However, the alternative also provides for a downsizing of the present observer program (FMP 2.2) up to its complete elimination (FMP 2.1). Because information collected by the observer program is crucial to stock assessments, its elimination means that targeted stocks may not be efficiently managed. The net affect could be quite detrimental to groundfish populations particularly given the increase in fishing pressure under the alternative.

A more aggressive harvest strategy could increase economic discards. Easing of the IR/IU program (detailed below) up to its full elimination under FMP 2.1 would almost certainly increase the number of pollock and cod discards. In the BSAI, the original implementation of the IR/IU program resulted in an immediate decrease in the discard for pollock from 94,800 mt to 16,200 mt, and for Pacific cod from 22,100 mt to 4,300 mt. A combination of phasing out of the program and increased fishing under Alternative 2 could result in pollock and cod discard rates notably higher than pre-IR/IU levels. The mandatory retention program currently scheduled to take effect under Alternative 1 for selected species of flatfish would also be abandoned. Increased harvests of target species could result in proportionate increases in economic discards in many of groundfish fisheries.

6.2.2 Prohibited Species

Halibut

The elimination of bycatch restrictions is not likely to have a significant biological impact on the halibut population over the long-term regardless of the management measures adopted within the range offered under Alternative 2. The halibut population is presently healthy and total catch has been near record levels. Any increase in bycatch would be incorporated into IPHC stock assessments and harvest quotas. Lower harvest quotas would offset increased bycatch. The effect would be an economic loss to the directed halibut fisheries.

Herring

The Pacific herring population would be largely unaffected by increased bycatch mortality over the long-term regardless of the management measures adopted within the range offered under Alternative 2. ADF&G adjusts annual harvest quotas relative to projected herring biomass in the BSAI and GOA. Lower harvests in the nearshore state fisheries would offset increased bycatch mortality. The effect would be an economic loss to the directed herring fisheries.

King and Tanner Crabs

Crabs are the group most likely to be at long-term risk as the result of relaxed bycatch restrictions, particularly the elimination of time and area closures. Many of the crab stocks in the BSAI are currently at or below critical levels. As discussed under Alternative 1, agency analysts contend that the greater danger to crabs comes from trawls that disrupt essential crab habitat. Closed areas thus tend to be more effective than PSC limits in reducing the impact of trawling on crab stocks. If time and area closures and gear restrictions are lifted under Alternative 2, there is a real potential for damage to crab stocks in areas of high aggregation. It is a virtual certainty that the complete repeal of time area closures and gear restrictions that would be reached under FMP 2.1 would have serious detrimental consequences to crab stocks.

As was the case for Alternative 1, there is little information on the sizes and status of GOA crab stocks. There is no way to determine the proportion of each stock being affected by bycatch or if critical crab habitat is being damaged in any substantial way.

Pacific Salmon

Under Alternative 2, PSC limits in the BSAI would remain at the levels that currently exist under Alternative 1 (FMP 2.2) or be eliminated completely (FMP 2.1). There are currently no bycatch restrictions in the GOA so no change would occur.

For the reasons described under Alternative 1, it is possible that current PSC restrictions in the BSAI management region may not be providing adequate protection to some depleted western chinook salmon stocks. If this is the case, the removal of PSC limits could exacerbate the situation and more at-risk chinook salmon might be taken. Further, Alternative 1 PSC limit of 29,000 fish represents about 11.6 to 22.3 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chinook salmon landings reported between 1997 and 1999. This is a substantial portion of the domestic harvest. Elimination of PSC limits would increase these proportions even further.

Western Alaska stocks of chum salmon are also depressed. Under Alternative 1, analysts estimate that about 19 percent of chum salmon bycatch in the BSAI is from western stocks and that this is equivalent to only 1.3 to 1.5 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999. This bycatch represents a tiny fraction of landings, even for depressed stocks. Under FMP 2.1, there might be a 15 to 20 percent increase in the harvests of target species, which could result in a proportionate increase in chum salmon bycatch throughout the entire BSAI. This would still be equivalent to only a small fraction of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999.

Current PSC restrictions on chum salmon are limited to the catcher vessel operation area where 42,000 "other" salmon can be taken between August 15 and October 15, a period when chum salmon bycatch in the trawl pollock fishery is very high. Even if the PSC limit were lifted, pollock fishing in the Savings Area would be limited by seasonal allocations of TAC which, under Alternative 2, remain the same as Alternative 1. Further, there is considerable spatial overlap of the chum salmon Savings Area with the SCA, which greatly limits pollock fishing in that region of the Bering Sea. It is unlikely that the removal of the PSC limits and increased pollock TAC would seriously affect at-risk western chum salmon stocks.

As discussed under Alternative 1, the bycatch of sockeye, coho, and pink salmon are insignificant in the BSAI and GOA relative to seasonal harvests in directed Alaskan fisheries. The bycatch of ESA-listed salmon stock for Washington, Oregon, and California are also nominal. These stocks would remain unaffected regardless of the management measures adopted within the range offered under Alternative 2.

6.2.3 Forage Species

Alternative 2 would affect the bycatch of forage fish in two ways: 1) under FMP 2.1, the repeal of bycatch restrictions would mean the elimination of 2 percent MRA limits for forage fish, and 2) the increase in groundfish fishing effort could result in a proportionate increase in bycatch.

In most instances, the bycatch for forage fish is far less than 1 percent in any of the targeted fisheries. From 1997 to 1999, the proportionate bycatch of forage fish relative to the total target fish harvest was less than 0.01 percent in the BSAI and 0.39 percent in the GOA. When averaged over the fishery, bycatch was well below MRA limits. If these trends are indicative of long-term bycatch trends in the groundfish fishery, then easing of the 2 percent cap, up to its full elimination under FMP 2.1, is not likely to substantially increase bycatch overall simply because the MRA limits are not normally reached anyway when averaged over the entire fishery. Because bycatch rates are so low, even an increase in harvest under Alternative 2, up to a maximum increase of 15-20 percent that would occur under FMP 2.1, is not likely to increase the bycatch of forage fish by more than that. For the reasons discussed under Alternative 1, it is unlikely that bycatch would seriously impact forage fish stocks regardless of the management measures adopted within the range offered under Alternative 2.

There is a provision under Alternative 2.2 for the establishment of a directed fishery for forage fish. Although the effects of a directed fishery is a TAC and not a bycatch issue, increased fishing pressure on any of the targeted species that would accompany such a measure could require re-evaluation of bycatch effects, particularly on a localized scale.

6.2.4 Other Species

The management of "other" species under Alternative 2 is the same as for Alternative 1. Although the "other" species group is currently managed as an aggregate, the NPFMC has proposed that TACs and bycatch restrictions be developed on an individual species basis for skates and rays. It is assumed that additional species may be singled out as additional information is gathered. Any enhanced focus on individual species within the "other" species category could eventually prove beneficial to disproportionately exploited species, should they exist.

6.2.5 Nonspecified Species

Under Alternative 1, there is currently no management and only limited monitoring of any species in this category. Little is known about the ecology of many of the species and it is difficult to assess the effects of this policy. No additional protection would be offered this group under Alternative 2. As with Alternative 1, there is insufficient information on the species within this group with which to assess the potential effects of the plan.

6.2.6 Observer Program

The alternative provides for a downsizing of the present observer program (FMP 2.2) up to its complete elimination (FMP 2.1). The observer program serves a crucial role in gathering data essential for monitoring bycatch in the groundfish fishery. Any reduction in the observer program would impede the effectiveness of what is essentially the onsite eyes and ears of the entire fisheries management system. Record keeping and reporting requirements mandated by the NPFMC for operational fishing vessels provide some essential management information, but they do not provide the kinds of detailed and independent catch data that is supplied by onboard observers. A repeal of the program could have a significantly adverse effect on bycatch management and, in turn, the health and stability of all groundfish stocks and other living marine resources.

6.2.7 Improved Retention/Improved Utilization

The alternative ranges from maintaining the present IR/IU program (FMP 2.2) up to its complete repeal (FMP 2.1). In 1998, the year the amendment was implemented, discards in the BSAI dropped for pollock from 94,800 mt to 16,200 mt, and for Pacific cod from 22,100 mt to 4,300 mt. Relaxation of the 100 percent retention policy up to full repeal would allow for a corresponding increase in economic discards. As discussed above under Target Species, pollock and cod populations are managed via stringent stock assessment models and TAC allocations, and discard losses are taken into account when determining yearly harvest quotas. The presence or absence of an IR/IU program would have no effect on stocks. However, the elimination of the IR/IU program would increase economic discards. The mandatory retention program currently scheduled to take effect under Alternative 1 for selected flatfish species would also be abandoned.

6.2.8 Vessel Incentive Program

There are no proposed changes in the VIP that is currently implemented under Alternative 1. However, it cannot be implemented without an observer program, and the observer program would be eliminated under FMP 2.1.

6.3 Indirect Effects

6.3.1 Spatial and Temporal Concentrations in Bycatch

Overall, there is insufficient information with which to assess the effects of spatial and temporal concentrations in bycatch (see Spatial and Temporal Concentrations in Bycatch under Alternative 1).

6.3.2 Socioeconomic

The primary benefit of Alternative 2 would be an economic boost to the groundfish industry at the expense of other fisheries (e.g., halibut, crab, and herring). The plan would gradually open the North Pacific to a less restrictive fishing environment and allow for larger and more economically-efficient harvests. Fishing would still be limited by management strategies to maximize the sustainable yields of targeted stocks but fishing efforts would be less encumbered by bycatch restrictions. Halibut PSC limits alone typically limit the harvest of some flatfish species. Virtually all herring bycatch occurs in the pollock fishery, which is the largest groundfish fishery in Alaskan waters.

The degree of economic benefit under Alternative 2 is problematic and would depend on a number of factors including the costs and benefits of extended fishing seasons, fishing seasons less constrained by specific time or area allocations, and the voluntary retention of marketable species. Some fisheries would benefit more than others. Pollock occur primarily in well defined aggregations and if fishing fleets encounter a hot spot they may be able to "top off" their seasonal TAC allocation rapidly (cost effectively) and with minimal bycatch. Some flatfish species that are more widely dispersed may be more costly to harvest even without bycatch restrictions.

The economic advantage conferred on the groundfish industry by Alternative 2 would come at the expense of other domestic fisheries in the region. Decreased fishing effort in the domestic fisheries would compensate for increased bycatch mortality in the groundfish fishery. Whether the economic loss to domestic fisheries would in any way be substantial is a matter for economic analysis.

6.4 Cumulative Effects

6.4.1 Biodiversity

There is insufficient information on the ecological and genetic diversity of fish species and benthic fauna in the BSAI and GOA to assess the cumulative effects of the alternative on biodiversity. Factors unrelated to the groundfish fishery are far more likely to be the principal agents driving species diversity in the region (see Biodiversity under Alternative 1, Section 5.7.2).

6.4.2 Predator-Prey Relationships

In general, it is unlikely that the increased bycatch that would occur under Alternative 2 would have any significant effect on predator-prey relationships (see Predator-Prey Relationships under Alternative 1, Section 5.7.2). At a localized level, however, depletion of specific size or age groups could have short term effects on predator-prey relationships. Such impacts might be difficult to detect and their ramifications difficult to ascertain.

6.4.3 Ecosystem Energy Balance

It is unlikely that the increase in bycatch associated with the alternative will have a significant effect on the energy budgets of the BSAI and GOA (see Ecosystem Energy Balance under Alternative 1, Section 5.7.3).

Section 7 Alternative 3: Adopt a More Precautionary Management Policy

7.1 Policy Goals and Objectives

Under this alternative a more precautionary harvest strategy would be implemented. Details of policy goals and objectives are outlined in the section entitled Policy Alternatives and Rationale. Specific Illustrative FMP measures for Alternative 3 are summarized in Table 3.

7.2 Direct Effects

The overall bycatch effect of Alternative 3 would be a general decrease in bycatch and bycatch mortality for all five species categories (e.g., target, prohibited, forage, other, and nonspecified species). The extent of bycatch reduction would depend upon the degree to which management policy would shift from a moderately more restrictive bycatch policy (FMP 3.1) to a substantially more extensive use of both market oriented bycatch reduction incentives and restrictive bycatch policy (FMP 3.2). Bycatch would further be reduced by provisions in Alternative 3 which would decrease TACs in the directed fisheries from current Alternative 1 levels (FMP 3.1) to lower levels with the TAC provisions outlined under FMP 3.2. More stringent management of individual species groups within the "other" and nonspecified categories would allow for more precise control of bycatch mortality and their effects on stocks. Expanded time and area closures would offer enhanced protection to crab, herring, salmon, and halibut populations and fisheries. The direct effects of Alternative 3 provisions to the different species groups and management tools are detailed below.

7.2.1 Target Species

Under a more restrictive management policy, fishing effort and harvests would decrease throughout the groundfish fishery. Change in the bycatch of a target species and adjustments in gear restrictions and allocations are not likely to have a significant effect on that population. Because bycatch mortality is incorporated into stock assessments that are used by the NPFMC and NOAA Fisheries to set TAC limits and to monitor total catch with respect to those TACs, the resulting decreases in discards will tend to be replaced with increases in retained catch. Therefore, compared to the target species stock effects for the TAC policies of Alternative 3, the effects of the bycatch policies are expected to be minimal.

7.2.2 Prohibited Species

Halibut

Under Alternative 3, PSC limits in the BSAI and GOA could be lowered from 0-10 percent (FMP 3.1) to 10-30 percent (FMP 3.2). The use of market oriented incentives to decrease bycatch would be expanded substantially under FMP 3.2. The expected reductions in halibut bycatch and bycatch mortality are not likely to have a significant biological impact on the halibut population over the long-term regardless of the management measures adopted within the range offered under Alternative 3. Any decrease in bycatch mortality would be incorporated into IPHC stock assessments and harvest quotas. Any benefit conferred on the halibut population by lower bycatch would eventually be offset by higher harvests in the halibut fishery. The halibut fishery would incur positive economic benefits, in some cases, at the expense of the groundfish fishery.

Herring

The Pacific herring population would be unaffected by the expected reductions in herring bycatch and bycatch mortality over the long-term, regardless of the management measures adopted within the range offered under Alternative 3. ADF&G adjusts annual harvest quotas in state domestic fisheries based upon herring stock projections. Any benefit conferred on the herring population by lower groundfish fishery

bycatch would eventually be offset by higher harvests in the directed state fisheries. Economic benefits would accrue to the herring fishery, in some cases, at the expense of the groundfish fishery.

King and Tanner Crabs

Under Alternative 3, PSC limits in the BSAI could be lowered from 0-10 percent (FMP 3.1) to 10-30 percent (FMP 3.2). PSC limits would be established for the GOA based upon stock and fishery data, then lowered 0-10 percent. Time/area/gear closures in the BSAI would remain consistent with Alternative 1. Appropriate closures would be implemented in the GOA based upon scientific study. Finally, the use of market oriented incentives to decrease bycatch would be expanded substantially under FMP 3.2. The expected reductions in crab bycatch and in the adverse effects trawling would have on crab habitat would allow a more rapid recovery of the crab stocks and fisheries.

As discussed under Alternative 1, closed areas tend to be more effective than PSC limits in reducing the impact of trawling on crab populations. Nevertheless, reduced PSC limits, and bycatch reduction incentives would help curtail bycatch and bycatch mortality. Maintaining closures in the BSAI would continue to have a significantly beneficial effect on crab stocks. The development of appropriate closures in the GOA could similarly be beneficial to crab populations in that region.

Salmon

Under Alternative 3, PSC limits in the BSAI would be lowered to the extent practical from 0-10 percent (FMP 3.1) to 10-30 percent (FMP 3.2). In the GOA, PSC limits would be established at 25,000 fish for chinook and 20,500 fish for other salmon. Finally, the use of market oriented incentives to decrease bycatch would be expanded substantially under FMP 3.2. Because salmon stocks in Alaska are rigorously managed by ADF&G and are generally considered healthy, any benefit conferred by lower bycatch would eventually be offset by higher harvests in the state's commercial, subsistence, and recreational fisheries. Economic benefits would accrue to these fisheries. Any additional protection afforded salmon populations under Alternatives 3 would, therefore, have no long-term effect on stock status.

The possible exceptions are at-risk western stocks of chinook salmon that may be taken as bycatch in the BSAI (see Alternative 1). At present, there is insufficient information with which to determine if these at-risk stocks are being seriously impacted by bycatch in the BSAI under Alternative 1. It would be equally difficult to quantitatively determine if increased protection offered under Alternative 3 would be sufficient to protect these stocks from further depletion. Qualitatively, reduced PSC limits ranging from 0-10 percent under FMP 3.1 to 10-30 percent under FMP 3.2 should offer proportionate protection to at-risk western chinook salmon stocks.

Alternative 3 would establish blanket PSC limits (FMP 3.1 to FMP 3.2) of 25,000 chinook salmon and 20,500 "other" salmon in the GOA. Since there is no indication that salmon stocks of any species are being adversely affected by the current absence of PSC limits in the GOA, it is unlikely that additional protection would have any effect on salmon populations.

7.2.3 Forage Fish

For the reasons outlined for Alternative 1, the bycatch of forage fish under Alternative 1 is not likely to have an effect on forage fish stocks. Additional reductions in bycatch under Alternative 3 would, therefore, provide no additional benefit to forage fish populations.

7.2.4 Other Species

Alternative 3 includes measures that would remove sharks and skates from the other species category and establish individual TACs for each. The NPFMC would also have the choice, based upon available scientific information, of removing the remaining species groups (sculpin, octopi, and GOA squid) from the other species category and likewise managing them via individual TACs (FMP 3.2). Enhanced focus on individual

species or species groups would provide for a more rigorous management of stocks both in terms of TAC and possible bycatch restrictions. In addition, the use of market oriented incentives to decrease bycatch would be expanded substantially under FMP 3.2. Such measures could offer greater protection to species that are disproportionately exploited under the current aggregate management plan if they indeed are at risk.

7.2.5 Nonspecified Species

Alternative 3 would seek to develop criteria to bring nonspecific species into a managed category. Because little is known about the population dynamics of many of the species in this category, it is difficult to assess the effects of this policy. However, the establishment of management practices typically promotes directed research toward specific species or species groups. This could enhance the NPFMC's understanding of population dynamics for species within this group and result in greater protection for stocks that may currently be at risk from unregulated bycatch take. In addition, the use of market oriented incentives to decrease bycatch would be expanded substantially under FMP 3.2 and could be applied to these species as a group or to identifiable subgroups.

7.2.6 Observer Program

Alternative 3 calls for an expansion in the observer program from Alternative 1 (FMP 3.1) to complete coverage of all vessels greater than or equal to 60 ft in length (FMP 3.2). The current FMP management plan requires 100 percent coverage on vessels greater than 124 ft, but only 30 percent coverage on vessels ranging from 60 to 124 ft in overall length. An expanded observer program could only enhance the ability of the NPFMC and NOAA Fisheries to monitor and regulate bycatch and to successfully implement market oriented solutions to the bycatch problems in the groundfish fishery. The key issue would be the cost of implementing such an expanded program.

7.2.7 Improved Retention/Improved Utilization

The provisions under Alternative 3 are the same as under Alternative 1.

7.2.8 Vessel Incentive Program

Under Alternative 3, the current VIP would be replaced with a number new conservation measures. Most options would include market oriented incentives to reduce bycatch and bycatch mortality. Such incentives would decrease the cost and increase the benefit of reducing bycatch for individual fishing operations and, therefore, make further reductions in bycatch practicable.

7.3 Indirect Effects

7.3.1 Spatial and Temporal Concentrations in Bycatch

Overall, there is insufficient information with which to assess the effects of spatial and temporal concentrations in bycatch (see Spatial and Temporal Concentrations in Bycatch under Alternative 1).

7.3.2 Socioeconomic

Alternative 3 includes more restrictive command and control solutions to the bycatch problems, as well as market oriented solutions. The latter would decrease the economic burden imposed on the groundfish industry by the former and could decrease substantially the need for the former. The direction and magnitude of the net effect on the groundfish industry is a matter for economic analysis and would depend on a number of factors including the costs and benefits of the specific restrictions and market oriented solutions that would be implemented. Some fisheries would be impacted more than others.

Decreased bycatch of groundfish or prohibited species by some groundfish fishing operations would benefit others and decreased bycatch of non-groundfish species would benefit those who participate in other fisheries in the region. Halibut, herring, crab, and salmon fisheries are managed with the primary goal of maintaining healthy, productive, and sustainable populations that will support commercial, subsistence, and recreational fisheries over the long-term. Reduced bycatch mortality in the groundfish fishery would eventually be realized as higher yields in domestic fisheries. Whether the gain to domestic fisheries would in any way be substantial is a matter for detailed economic analysis.

7.4 Cumulative Effects

7.4.1 Biodiversity

There is insufficient information on the ecological and genetic diversity of fish species and benthic fauna in the BSAI and GOA to assess the cumulative effects of Alternative 3 on biodiversity. Factors unrelated to the groundfish fishery are far more likely to be the principal agents driving species diversity in the region (see Biodiversity under Alternative 1).

7.4.2 Predator-Prey Relationships

It is highly doubtful that decreased bycatch associated with Alternative 3 will have any significant effect on predator-prey relationships (see Predator-Prey Relationships under Alternative 1).

7.4.3 Ecosystem Energy Balance

It is highly unlikely that the decrease in bycatch associated with the alternative will have a significant effect on the energy budgets of the BSAI and GOA (see Ecosystem Energy Balance under Alternative 1).

Section 8 Alternative 4: Adopt a Highly Precautionary Management Policy

8.1 Policy Goals and Objectives

Under this alternative an extremely precautionary harvest strategy would be implemented. Details of policy goals and objectives are outlined in the Policy Alternatives and Rationale section. Specific Illustrative FMP measures for Alternative 4 are summarized in Table 3.

8.2 Direct Effects

The overall bycatch effect of Alternative 4 would be a major decrease in bycatch and bycatch mortality for all five species categories (e.g., target, prohibited, forage, other, and nonspecified species). More stringent management of individual species groups within the "other" and nonspecified categories would allow for more precise control of bycatch mortality and their effects on stocks. A greater prevalence of time and area closures would offer enhanced protection to crab, herring, salmon, and halibut populations. Protections would be maximized under FMP 4.2 which would close the groundfish fishery altogether. The direct effect of Alternative 4 provisions to the different species groups and management tools is detailed below.

8.2.1 Target Species

Under a more restrictive management policy, fishing effort and harvests would decrease throughout the groundfish fishery. Any change in the bycatch of a target species is not likely to have a significant effect on that population. Because bycatch mortality is incorporated into stock assessments that are used to set TAC limits and to monitor total catch with respect to those TACs, the resulting decreases in discards will tend to be replaced with increases in retained catch. Therefore, compared to the target species stock effects of the TAC policies of Alternative 3, the effects of the bycatch policies of Alternative 4 are expected to be minimal. Decreased harvests and an IR/IU program for all target species could substantially reduce economic discards. FMP 4.2 would eliminate all bycatch. It would also eliminate the fishery.

8.2.2 Prohibited Species

Halibut

More stringent bycatch restrictions and a more limited groundfish fishery are not likely to have a significant biological impact on the halibut population over the long-term regardless of the management measures adopted within the range offered under Alternative 4. Any decrease in bycatch mortality would be incorporated into IPHC stock assessments and harvest quotas. Any benefit conferred on the halibut population by lower bycatch would eventually be offset by higher harvests in the directed halibut fishery. The directed halibut fishery would incur positive economic benefits at the expense of the groundfish fishery.

Herring

The Pacific herring population would be unaffected by more stringent bycatch restrictions and a more limited groundfish fishery regardless of the management measures adopted within the range offered under Alternative 4. ADF&G adjusts annual harvest quotas in state domestic fisheries based upon herring stock projections. Any benefit conferred on the herring population by lower groundfish fishery bycatch would eventually be offset by higher harvests in the directed state fisheries. The directed herring fishery would see positive economic benefits at the expense of the groundfish fishery.

King and Tanner Crabs

Under Alternative 4, PSC limits in the BSAI would be lowered to the extent practical from 30-50 percent (FMP 4.1) to PSC = 0, the complete closure of the fishery (FMP 4.2). In the GOA, PSC limits would be established based upon biomass and fisheries data, then lowered 30-50 percent. Additional closures would be established for the BSAI and GOA (FMP 4.1) and expanded to full closure of all crab habitats (FMP 4.2).

As discussed under Alternative 1, closed areas tend to be much more effective than PSC limits in reducing the impact of trawling on crab populations. Thus, the beneficial crab stock effects of more restrictive PSC limits are expected to be greater if those limits trigger area closures. Expanding closures in the BSAI and GOA would provide added protection to crab stocks. The closure of the groundfish fishery under FMP 4.2 would maximize this protection.

Salmon

Under Alternative 4, PSC limits in the BSAI would be lowered to the extent practical from 30-50 percent (FMP 4.1) to PSC = 0, or the closure of the fishery (FMP 4.2). In the GOA, PSC limits would be established at 25,000 fish for chinook and 20,500 fish for other salmon (FMP 4.1) and would remain in effect until complete closure of the fishery (FMP 4.2). Because salmon stocks in Alaska are rigorously managed by ADF&G and are generally considered healthy, any benefit conferred by lower bycatch would eventually be offset by higher harvests in the state's commercial, subsistence, and recreational fisheries. Domestic fisheries would benefit economically at the expense of the groundfish fishery.

The possible exceptions are at-risk western stocks of chinook salmon that may be taken as bycatch in the BSAI. There is insufficient information with which to determine if these at-risk stocks are being seriously impacted by bycatch in the BSAI under Alternative 1. Likewise, it is difficult to quantitatively determine if decreased bycatch under FMP 4.1 would sufficiently protect these stocks. Unless improved stock assessment and identification methods are developed, the no fishing provision under FMP 4.2 is the only measure that would guarantee full protection from the groundfish fishery to at-risk western chinook salmon stocks. It is not known how that high level of protection would affect the recovery of those salmon stocks.

8.2.3 Forage Fish

For the reasons outlined for Alternative 1, the bycatch of forage fish under Alternative 1 is not likely to have an effect on forage fish stocks. Additional reductions in bycatch under Alternative 4 would, therefore, provide no additional benefit to forage fish populations.

8.2.4 Other Species

Alternative 4 would set the TAC of species complexes within the other species category based upon the least abundant member of the group. It is assumed that any management strategy focusing on TACs could ultimately affect bycatch restrictions for that group. It is also assumed that the least abundant criterion is based upon the idea that least abundant, or rare, species are somehow at greater risk and that management strategy should center on protecting these most vulnerable stocks. While rare species may be more vulnerable to fishing pressures, sufficient scientific information would need to be gathered to verify such a conclusion for any given case. Low abundance of a particular other species could merely be the result of the directed fishery operating outside the primary distribution range of that species. Nevertheless, a more restrictive fishing policy could offer greater protection to species that are disproportionately exploited under the current aggregate management plan.

8.2.5 Unspecified Species

The FMP 4.2 extreme is a complete fishing ban; i.e., TAC = 0 for all species. Because little is known about the ecology of many of the species in the "unspecified species" category it is difficult to assess the effects of this policy. However, a no fishing alternative would completely eliminate the possibility of any unspecified species being overfished as bycatch.

8.2.6 Observer Program

Alternative 4 would expand observer coverage from 30 percent to 100 percent on all vessels 60-124 ft in length, and from 0 percent to 30 percent on all vessels less than 60 ft in length. It would also require that 100 percent of the hauls be observed. An expanded observer program could only enhance the ability of the NPFMC and NOAA Fisheries to monitor and regulate bycatch in the groundfish fishery and to successfully implement incentives to reduce bycatch. The key issue would be the cost of implementing such an expanded program.

8.2.7 Improved Retention/Improved Utilization

Alternative 4 calls for an expansion of the IR/IU program to all target species (FMP 4.1) up to the full prohibition on bycatch (FMP 4.2) which is effectively a no fishing alternative. Any expansion of the 100 percent retention policy would allow for a corresponding decrease in economic discards for all target species. Because target species are managed via stringent stock assessment models and TAC allocations, a reduction in discards would be taken into account when determining yearly harvest quotas. Any benefit conferred on target species would eventually be offset by higher harvests in the directed groundfish fisheries. Expansion of the IR/IU program up to a full prohibition on fishing would likely have no significant effect on groundfish stocks but would decrease discards. Full retention might also cause boats to top off sooner, which could result in shorter trips and less take overall.

8.2.8 Vessel Incentive Program

There are no proposed changes in the VIP as currently implemented under Alternative 1.

8.3 Indirect Effects

8.3.1 Spatial and Temporal Concentrations in Bycatch

Overall, there is insufficient information with which to assess the effects of spatial and temporal concentrations in bycatch (see Spatial and Temporal Concentrations in Bycatch under Alternative 1). FMP 4.2 would completely shut down the groundfish fishery and render the issue moot.

8.3.2 Socioeconomic

The primary impact of Alternative 4 would be to increase the economic burden on the groundfish industry. The plan would implement a more restrictive fishing environment and result in less economically efficient harvests. The degree of economic loss is a matter of economic analysis and would depend on a number of factors including the costs and benefits of more restricted fishing seasons, and fishing seasons more constrained by specific time/area allocations and closures. Some fisheries would be impacted more than others. FMP 4.2 would completely shut down the groundfish fishery.

Decreased bycatch of groundfish or prohibited species by some groundfish fishing operations would benefit others and decreased bycatch of non-groundfish species would benefit those who participate in other fisheries in the region. Halibut, herring, crab, and salmon fisheries are managed with the primary goal of maintaining healthy, productive, and sustainable populations that will support commercial, subsistence, and recreational fisheries over the long-term. Reduced bycatch mortality in the groundfish fishery would eventually be

realized as higher yields in the fisheries for those species. Whether the net gain to all regional fisheries combined would in any way be substantial is a matter for detailed economic analysis.

8.4 Cumulative Effects

8.4.1 Biodiversity

There is insufficient information on the ecological and genetic diversity of fish species and benthic fauna in the BSAI and GOA to assess the cumulative effects of the alternative on biodiversity. Factors unrelated to the groundfish fishery such as introduction of non-indigenous species, natural fluctuations in the relative abundance of species within the food web, and long-term climatic changes are far more likely to be the principal agents driving species diversity in the region (see Biodiversity under Alternative 1).

8.4.2 Predator-Prey Relationships

It is highly doubtful that decreased bycatch associated with Alternative 4, even up to the point of eliminating the groundfish fishery, will have any significant effect on predator-prey relationships (see Predator-Prey Relationships under Alternative 1).

8.4.3 Ecosystem Energy Balance

It is highly unlikely that the decrease in bycatch associated with Alternative 4 will have a significant effect on the energy budgets of the BSAI and GOA (see Ecosystem Energy Balance under Alternative 1).

Section 9 Opportunities for Quantification

The most likely species for which quantitative impact assessments of bycatch can be made are those high profile groups that are the target of major fisheries in Alaska and the North Pacific. These would include Pacific halibut, Pacific herring, Pacific salmon (with selected exceptions), king and Tanner crab (in the BSAI), and target groundfish species such as walleye pollock, Pacific cod, and yellowfin sole or any other species managed under Tiers 1-3 (Appendix B). Because of their inherent economic value, these species are typically the subject of the most intense research and monitoring efforts and, therefore, are the species for which the most comprehensive scientific information is available. The irony is that because these stocks are some of the most rigorously managed, they are the least vulnerable to losses attributable to bycatch. Any increase or decrease in bycatch would ultimately be offset by increased or decreased harvests in the directed fishery. Management effectively buffers the populations from the effects of bycatch. The major exceptions are crabs, in which loss or a gain in critical habitat under the different alternatives could tangibly affect stock health.

A second group for which nominal qualitative data may be available or compiled at a reasonable cost, is forage fish. While the forage fish category comprises eight fish families and euphausiid shrimp, the vast majority of fish taken as bycatch in the BSAI and GOA groundfish fisheries are osmerids (eulachon, capelin, and other smelts). Non-osmerids are, therefore, not a serious bycatch issue. Recent declines in North Pacific seabird populations have prompted research into the health and status of regional forage fish stocks that are such an important food source for seabirds. Because osmerids are R-selected, populations tend toward wide fluctuations in abundance. Nevertheless, even coarse estimates of osmerid abundance and predator biomass based upon Alaska Fisheries Science Center (AFSC) and NPFMC/NOAA Fisheries sponsored research, might be adequate to determine whether the bycatch of several mt of forage fish is truly detrimental to the North Pacific food web.

Section 10 Data Gaps and Information Needs

There are substantial gaps in our understanding of the biological, ecological, social, and economic effects of bycatch and of alternative methods for reducing bycatch. Therefore, it is difficult to determine the extent to which it is practicable to reduce bycatch. The problem is increased by the fact that bycatch is a multi-species problem in which a management measure that decreases the bycatch of some species can often increase the bycatch of other species.

There is very little scientific information available on the biology and ecology of individual species within the other species and nonspecified species categories. There is concern that species within these groups might be disproportionately impacted by losses attributable to bycatch. This is particularly true for long-lived species with low reproductive potential that are less resilient to fishing pressures. Other species are presently managed with an aggregate TAC and there is no way to determine if individual species are being overfished relative to their population level. Unspecified species may be taken without restriction. The NPFMC is presently trying to develop individual TACs and bycatch restrictions on individual taxa within the other species category in an attempt to protect vulnerable species. However, any realistic management plan will require more research into the population structure and community dynamics of individual taxa. One approach to the problem would be to prioritize species based upon their presumed risk. For example, bycatch of grenadiers is higher in the GOA than all species in the other species category combined. This alone would make this species a prime candidate for further research.

There is little information on the degree to which at-risk western stocks of chinook salmon have been affected by bycatch in the BSAI. Yukon and Kuskokwim river stocks are seriously depleted. Low stock sizes have resulted in reduced harvests that have seriously impacted some Alaskan fisheries in recent years. Excess bycatch in the groundfish fishery could further jeopardize these populations. The NPFMC has responded by adopting Amendment 58 which will 1) reduce the chinook salmon bycatch limit to 29,000 fish over a four-year period, 2) implement year-round accounting of chinook salmon bycatch in the pollock fishery, 3) revise the boundaries of the Chinook Salmon Savings Areas, and 4) set more restrictive closure dates. Future responses to localized salmon stock depletions could be enhanced through a comprehensive (genetic) stock identification program, which would allow for more precise identification and management of salmon populations. A stock identification program would be mutually beneficial to state and federal interests and, as such, would likely require a joint effort encompassing ADF&G, AFSC, NOAA Fisheries, the NPFMC, and Academia.

Obtaining the biological data needed to enhance bycatch management of other and nonspecified species would likely require a protracted research effort by NOAA Fisheries and AFSC. Given the number of taxa involved, species of interest or concern would need to be prioritized in terms of their importance to the ecosystem, their potential vulnerability to impact, the costs of obtaining the data required to manage individual species, and a determination would have to be made as to whether the resources are available to obtain such data. That determination would require detailed assessments by AFSC, NOAA Fisheries, and the NPFMC. In addition, a protracted research effort by NOAA Fisheries and AFSC would be required to obtain the data and develop the models necessary to estimate the social and economic effects of bycatch and of alternative methods for reducing bycatch.

Section 11 Comparative Analysis of Alternatives

The three groundfish fishery management alternatives to Alternative 1 call for a more aggressive harvest strategy (Alternative 2), a more precautionary harvest strategy (Alternative 3), and an extremely precautionary harvest strategy (Alternative 4). In terms of the direct effects of bycatch and discard waste on individual fish populations, none of these alternatives is likely to have a significant impact on target groundfish species, Pacific halibut, Pacific herring, forage fish species, coho salmon, sockeye salmon, pink salmon, chum salmon, or any North Pacific salmon stock currently listed as endangered or threatened under the ESA. Being the targets of directed fisheries, target groundfish and PSC (halibut, herring, salmon) species are rigorously managed to ensure that populations remain healthy and robust over time. Losses to the population resulting from directed harvests far outweigh any loss attributable to bycatch. Further, any increase/decrease in bycatch that might occur under any of the alternatives would be offset by harvest allocation adjustments within the targeted fishery. Refer to Table 7 for a summary of the direct, indirect and cumulative effects of the alternatives on bycatch.

The exception to the above is the fate of target species under Alternative 2 which provides for a downsizing of the present observer program (FMP 2.2) up to its complete elimination (FMP 2.1). Because information collected by the observer program is crucial to stock assessments, its elimination means that targeted stocks may not be efficiently managed. The net affect could be quite detrimental to groundfish populations particularly given the increase in fishing pressure which would also occur under the alternative.

The bycatch of forage fish under all of the alternatives, including Alternative 1, is presumed to be only a small fraction of North Pacific stocks, and none of the alternatives would likely impact these populations although local depleted would have to be considered.

The two species groups that are targets in other fisheries and which could be directly affected by the alternatives are king and Tanner crabs, and depleted western stocks of chinook salmon. The crab and chinook salmon stocks that are currently depressed are more vulnerable to fishing impacts. The more aggressive harvest strategy of Alternative 2 could remove some of the protections that are offered these stocks under Alternative 1. Crabs are particularly vulnerable to benthic trawl disturbances and any repeal of area closures could seriously affect localized crab stocks. Conversely, added protection under Alternatives 3 and 4 could increase protection to these at-risk populations.

The projected impact of the three alternatives on other and nonspecified species can only be considered speculative. Little is known about the life histories and population dynamics of many of the species within these groups, and this makes it difficult to assess the effects of bycatch on individual stocks. There is concern that bycatch may disproportionately exploit and possibly deplete individual species, but the extent to which this might occur under Alternative 1 or any of the alternatives is unknown. Because the species within the other and nonspecified categories are not targets of directed fisheries, bycatch is the principal source of fishing mortality. Since Alternative 2 would generally increase catch and bycatch in the groundfish fishery, its bycatch impact on other and nonspecified species would conditionally be considered adverse simply because more fish would be taken as bycatch. Conversely, Alternatives 3 and 4 would be considered conditionally beneficial merely because of the generally reduced levels of bycatch. The expanded observer programs under the latter two alternatives would also enhance bycatch management for all species.

The indirect and cumulative effects of the different bycatch alternatives are also difficult to predict. Under Alternative 2, increased spatial or temporal concentrations of bycatch could overharvest distinct genetic components of a stock, alter local predator-prey relationships, change biodiversity, and/or adversely impact spawning grounds or aggregations. However, the dynamic nature of the North Pacific ecosystem and the complex interaction of physical and biological forces that drive and influence that system make it extremely difficult to assess the long-term effect of localized impacts, whether they be adverse or beneficial. Factors unrelated to the bycatch are far more likely to be the principal agents governing species diversity, food webs, and marine energy budgets in the region. Over the long-term, the potential changes caused by global climatic

shifts alone are likely to dominate the North Pacific ecosystem regardless of any groundfish management plan.

Economic effects of the different bycatch alternatives might be substantial. The more restrictive bycatch limitations implemented under Alternatives 3 and 4 would place greater economic burdens on the groundfishing industry. Harvest quotas would be more difficult to achieve and would require greater expenditures of time and money. However, with FMP 3.2, the substantially expanded use of market oriented solutions to the bycatch problem and other related management problems would tend to decrease the cost and increase the benefit of reducing bycatch for individual fishing operation. This would make further reductions in bycatch practicable, address the source of the problem of excess bycatch, and decrease the need for less efficient command and control solutions.

The FMP 4.2 would eliminate the groundfish industry. Any economic benefits would go to other fisheries (e.g., halibut, herring, salmon) by allowing them to eventually realize any reduction in bycatch as increased harvests. Conversely, under Alternative 2, the groundfish fishery would operate in a less restrictive atmosphere with higher permissible bycatch. Other directed fisheries would have to compensate for that bycatch by lowering harvest quotas. Whether these economic tradeoffs would result in substantial changes in the net benefit from all fisheries in aggregate is a matter for biological and economic analysis. Alternative 2 might also have geopolitical implications. Increased bycatch might be incompatible with management goals mandated by international treaties and agreements.

Table 7. Summary of the effects of the alternatives on bycatch.

Effect indicator	Alternative 1	Alternative 2		Alternative 3		Alternative 4	
	Fishery Management Plan (FMP) 1	FMP 2.1	FMP 2.2	FMP 3.1	FMP 3.2	FMP 4.1	FMP 4.2
Direct Biological Effects							
Target species	None: managed fishery.	Adverse: elimination of observer program compromises ability to manage stocks.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.
Prohibited Species Effects							
Halibut	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.
Pacific herring	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.
Pink and sockeye salmon	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.	None: managed fishery.
Coho salmon	General: none, managed fishery.	General: none, managed fishery.	Same as FMP 1.	General: none, managed fishery.	General: none, managed fishery.	General: none, managed fishery.	General: none, managed fishery.
Chinook and chum salmon	At-risk BSAI stocks: unknown.	At-risk BSAI stocks: adverse; less protection than FMP 1.		At-risk BSAI stocks: beneficial; more protection than FMP 1.	At-risk BSAI stocks: beneficial; more protection than FMP 3.1.	At-risk BSAI stocks: beneficial; more protection than FMP 3.2.	At-risk BSAI stocks: beneficial; eliminate bycatch.
King and Tanner crab	BSAI: beneficial; area closures protect crab habitat, psc limits lower mortality. GOA: unknown, insufficient data.	BSAI: adverse; easing of area closures that protect crab habitat, eliminate psc limits. GOA: unknown insufficient data.	Same as FMP 1.	BSAI: beneficial; stricter psc limits than FMP 1. GOA: beneficial; develop management measures.	BSAI: beneficial; stricter psc limits than FMP 3.1. GOA: beneficial; develop management measures.	BSAI: beneficial; increase area closures and stricter psc limits than FMP 3.2. GOA: beneficial; establish area closures and psc limits.	Beneficial; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries.
Forage species	Adverse effect unlikely.	Adverse effect unlikely establishment of a direct forage fish fishery may require re-evaluation of localized bycatch loss.	Adverse effect unlikely.	Adverse effect unlikely.	Adverse effect unlikely.	Adverse effect unlikely.	Beneficial; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries.

Table 7 (cont.). Summary of the effects of the alternatives on bycatch.

Effect indicator	Alternative 1	Alternative 2		Alternative 3		Alternative 4	
	Fishery Management Plan (FMP) 1	FMP 2.1	FMP 2.2	FMP 3.1	FMP 3.2	FMP 4.1	FMP 4.2
Other species	Unknown: increased management focus potentially beneficial, enhanced species protection.	Same as FMP 1.	Same as FMP 1.	Beneficial: increased management focus relative FMP 1, enhanced species protection.	Beneficial: increased management focus relative FMP 1, enhanced species protection.	Beneficial: increased management focus relative FMP 1, enhanced species protection.	Beneficial; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries.
Nonspecified species	Unknown: unmanaged.	Same as FMP 1.	Same as FMP 1.	Beneficial: increased management focus relative FMP 1 potentially beneficial, enhanced species protection.	Beneficial: increased management focus relative FMP 1 potentially beneficial, enhanced species protection.	Beneficial: increased management focus relative FMP 1 potentially beneficial, enhanced species protection.	Beneficial; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries.
Management effects							
Observer program	Beneficial: monitoring enhances management.	Adverse: elimination detrimental to management.	Adverse: downsizing detrimental to management.	Beneficial: expanded coverage relative FMP 1, enhances management Consideration: cost.	Beneficial: expanded coverage relative FMP 3.1, enhances management Consideration: cost.	Beneficial: expanded coverage relative FMP 3.2, enhances management Consideration: cost.	Irrelevant; temporary elimination of bycatch; Beneficial for authorized fisheries enhances management.
Improved retention/ improved utilization	Beneficial: decrease discards (waste).	Adverse: elimination increases discards (waste).	Same as FMP 1.	Same as FMP 1.	Same as FMP 1.	Beneficial: expanded program decreases discards (waste).	Irrelevant; temporary elimination of bycatch; fishing authorized only for environmentally safe fisheries.
Vessel incentive program	Marginally beneficial.	Same as FMP 1.	Same as FMP 1.	New programs considered, possibly beneficial in reducing waste.	New programs considered, possibly beneficial in reducing waste.	New programs considered, possibly beneficial in reducing waste.	Irrelevant; temporary elimination of bycatch; Beneficial in reducing waste for authorized fisheries.

Table 7 (cont.). Summary of the effects of the alternatives on bycatch.

Effect indicator	Alternative 1	Alternative 2		Alternative 3		Alternative 4	
	Fishery Management Plan (FMP) 1	FMP 2.1	FMP 2.2	FMP 3.1	FMP 3.2	FMP 4.1	FMP 4.2
Indirect effects							
Spatial/temporal concentrations	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.	Irrelevant: no fishery.
Socioeconomic	Adverse: groundfish fisheries Beneficial: non-groundfish fisheries.	Adverse: non-groundfish fisheries Beneficial: groundfish fisheries.	Adverse: non-groundfish fisheries Beneficial: groundfish fisheries.	Adverse: groundfish fisheries Beneficial: non-groundfish fisheries.	Adverse: groundfish fisheries Beneficial: non-groundfish fisheries.	Adverse: groundfish fisheries Beneficial: non-groundfish fisheries.	Adverse: groundfish fisheries (no fishery) Beneficial: non-groundfish fisheries.
Cumulative effects							
Biodiversity	Unknown: influenced more by factors unrelated to bycatch.	Unknown: influenced more by factors unrelated to bycatch.	Unknown: influenced more by factors unrelated to bycatch.	Unknown: influenced more by factors unrelated to bycatch.	Unknown: influenced more by factors unrelated to bycatch.	Unknown: influenced more by factors unrelated to bycatch.	Unknown: influenced more by factors unrelated to bycatch.
Predator-prey	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.
Relationship	Localized: unknown.	Localized: unknown.	Localized: unknown.	Localized: unknown.	Localized: unknown.	Localized: unknown.	Localized: unknown.
Ecosystem energy	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.	General: no adverse impact.
Balance	Localized: unknown.	Localized: unknown.	Localized: unknown.	Localized: unknown.	Localized: unknown.	Localized: unknown.	Localized: unknown.

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