Endangered Species Act
Section 7 Consultation - Biological Assessment

Agency: National Marine Fisheries Service

Activities Considered: Crab fisheries authorized under the Fishery Management Plan for Bering Sea/ Aleutian Islands King and Tanner Crabs

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TABLE OF CONTENTS

1.0 Purpose and Consultation History

This biological assessment addresses the impacts of Fishery Management Plan for Bering Sea/Aleutian Islands (BSAI) King and Tanner Crabs (FMP) and its effects on endangered marine mammal species and their critical habitat. With this assessment, NMFS is reinitiating a Section 7 consultation for the FMP.

Section 7(a)(2) of the Endangered Species Act, 16 U.S.C. § 1531 et seq., requires that each Federal agency shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a Federal agency may adversely affect a protected species, that agency (i.e., the "action" agency) is required to consult with either the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (FWS), depending upon the protected species that may be affected. For the actions described in this document, the action agency is NMFS's Sustainable Fisheries Division. Due to the protected species involved, the consulting agency is also within NMFS; i.e., NMFS's Office of Protected Resources. Section 7(b) of the Act requires that the consultation be summarized in a biological opinion detailing how the action may affect protected species.

The purpose of this assessment is to determine if crab fisheries, as conducted under the FMP, adversely affect listed species. Section 7 regulations allow consultation to encompass a number of similar actions within a given geographic area or a segment of a comprehensive plan (50 CFR 402.14). Consistent with this regulatory provision and for purposes of efficiency, all actions under the FMP are being summarized in a single biological assessment.

Commercial harvest for the following species is regulated under the FMP: red king crab (Paralithodes camtschatica), blue king crab (P. platypus), golden king crab (Lithodes aequispina), scarlet king crab (L. couesi), Tanner crab (Chionoecetes bairdi), snow crab (C. opilio), grooved Tanner crab (C. tanneri), and triangle Tanner crab (C. angulatus). The management area is defined as those waters of the U.S. EEZ that lie south of Point Hope, east of the U.S.-U.S.S.R. convention line of 1867, and extend south of the Aleutian Islands for 200 miles between the convention line and Scotch Cap Light. Crabs are taken in pots and catch is processed both onshore and at sea. Crab fishing seasons occur in the fall, winter, and early spring, depending on the fishery.

The following endangered and threatened species of marine mammals occur in the Bering Sea: Northern Right Whale (Balaena glacialis), Bowhead Whale (Balaena mysticetus), Sei Whale (Balaenoptera borealis), Blue Whale (Balaenoptera musculus), Fin Whale (Balaenoptera physalus), Humpback Whale (Megaptera novaeangliae), Sperm Whale, (Physeter macrocephalus), and the eastern and western populations of the Steller Sea Lion (Eumetopias jubatus). Critical habitat has been designated for the Stellar Sea Lion and the western population of Stellar Sea lion has been relisted as an endangered species.

In 1990, NMFS conducted a section 7 consultation on the FMP for the endangered humpback whale, blue whale, sei whale, fin whale, bowhead whale, right whale, sperm whale, and the threatened Steller sea lion. NMFS concluded that the BSAI commercial king and Tanner crab fisheries are not likely to adversely affect these endangered or threatened species or their critical habitat. NMFS is reinitiating consultation for the FMP because the change in listing for Steller Sea Lions from threatened to endangered and the designation of

Steller Sea Lion critical habitat.

2.0 The Crab Fisheries: Description of Actions

The purpose of this section is to describe the actions that are the subject of this assessment and thereby provide the background information needed to analyze their potential effects on protected species.

This section also provides summary descriptive information on the major target species of the fisheries under the FMP, including important life history traits, trophic interactions, fisheries, stock assessments, and recommended catch levels. These species and the respective fisheries are described in greater detail in the annual Crab Stock Assessment and Fishery Evaluation (SAFE) reports completed by the Crab Plan Team, and reviewed at various levels throughout the Council process. By reference, those SAFE reports are incorporated in this document in their entirety.

2.1 Fishery Management Plan for Bering Sea/Aleutian Islands (BSAI) King and Tanner Crabs

The crab stocks in the Bering Sea are managed by the State of Alaska (State) through the Federal FMP. Under the FMP, management measures fall into three categories: (1) those that are fixed in the FMP under Council control, (2) those that are frameworked so that the State can change following criteria outlined in the FMP, and (3) those measures under discretion of the State. Significant State actions and actions to ensure the FMP complies with the Magnuson-Stevens Act are either reviewed by or developed in conjunction with the Council's Crab Plan Team.

Management measures implemented for the BSAI king and Tanner crab fisheries, as defined by the federal crab FMP, by category.

Category 1 (Fixed in FMP)	Category 2 (Frameworked in FMP)	Category 3 (Discretion of State)
* Legal Gear	* Minimum Size Limits	* Reporting Requirements
* Permit Requirements	* Guideline Harvest Levels	* Gear Placement and Removal
* Federal Observer Requirements	* Inseason Adjustments	* Gear Storage
* Limited Access	* Districts, Subdistricts and Sections	* Gear Modifications
* Norton Sound Superexclusive Registration Area	* Fishing Seasons	* Vessel Tank Inspections
	* Sex Restrictions	* State Observer Requirements
	* Closed Waters	* Bycatch Limits (in crab fisheries)
	* Pot Limits	* Other
	* Registration Areas	

The Council approved the FMP in 1989. The FMP was revised and updated in 1999. The revised version of the FMP incorporates: 6 FMP amendments; catch data and other scientific information from the past 10 years; and changes due to amendments to the Magnuson-Stevens Act and other laws, a Russian/US boundary agreement, and a Federal/State Action Plan. The revised FMP included Amendment 7 to specify criteria for identifying overfishing and when a crab stock is overfished.

Since the FMP was revised, NMFS has approved Amendment 8 to establish Essential Fish Habitat. NMFS also approved Amendment 6 to modify the observer program, Amendment 9 to extend the moratorium program, and Amendment 13 to implement American Fisheries Act sideboards. NMFS published the notice of approval for Amendment 11, a rebuilding plan for Tanner crab, in the Federal Register (65 FR 38216).

The Council is developing Amendment 14, a rebuilding plan for snow crab, and Amendment 15, a rebuilding plan for St. Matthew blue king crab. The Council is also developing Amendment 12 to establish habitat areas of particular concern.

2.1.1 Fishery Management

This section discusses crab management in general, fisheries for each species are discussed separately in following sections.

The status of each species is assessed annually based on the best scientific information available. The abundance of the major crab stocks is estimated annually from data collected during the NMFS annual Eastern Bering Sea trawl survey and published in the NMFS annual Report to Industry. The crab stocks annually surveyed are: Bristol Bay red king crab, Pribilof Islands red king crab, Pribilof Islands blue king crab, St. Matthew blue king crab, eastern Bering Sea Tanner crab, and eastern Bering Sea snow crab. Alaska Department of Fish and Game (ADF&G) derives the guideline harvest levels (GHL) from these annual abundance estimates following harvest strategies developed for each species. Once the fishery reaches its GHL, ADF&G closes the fishery by emergency order. For crab species not surveyed, ADF&G estimates abundance using pot surveys and fishery information.

The crab fisheries target only large male crabs. Each fishery has a minimum size limit for male crab. All crab fisheries use pot gear. In addition to minimum size and sex restrictions, the State has instituted numerous other regulations for the Eastern Bering Sea crab fisheries. The State requires vessels to register with the state by obtaining licenses and permits, and register for each fishery and each area. Observers are required on all vessels processing king and Tanner crab in the BSAI. In 2000, the State expanded observer coverage to include 10% coverage of catcher vessels operating in the BSAI king and Tanner crab fisheries. The State requires catcher vessels operating in the golden king crab and C. tanneri and C. angulatus fisheries to have 100% observer coverage. State regulations also prescribe gear modifications to inhibit the bycatch of small crab, female crab, and other species of crab. Gear modifications include escape rings, tunnel size, and a requirement that crab pots be fitted with a degradable escape mechanism. The State has established pot limits for each fishery to limit effort in the crab fisheries.

Bering Sea Aleutian Islands King and Tanner crab fishing seasons

Snow crab	January 15
Golden king crab	August 15
St. Matthew/Pribilof Islands king crab	September 15
Bristol Bay red king crab	October 15
Tanner crab	October 15 / January 15

The State establishes fishing seasons following criteria in the FMP. Fishing seasons are established to achieve the biological conservation, economic and social, vessel safety, and gear conflict objectives of the FMP. Season opening dates are set to maximize meat yield, minimize handling of softshell crabs, and meet market demands. The adjacent table outlines the BSAI crab fishing seasons.

2.1.2 Overfishing Parameters

The FMP identifies the following overfishing definitions to provide objective and measurable criteria for identifying when the BSAI crab fisheries are overfished or overfishing is occurring, as required by the Magnuson-Stevens Act. Table 1 provides the minimum stock size threshold (MSST), maximum sustainable yield (MSY), optimum yield (OY), and MSY control rule estimates for the BSAI king and Tanner crab stocks. The Crab Plan Team will reevaluate these estimates every five years or when environmental conditions indicate a regime shift.

Table 1. MSST, MSY, OY, and the MSY control rule estimates for BSAI king and Tanner crab stocks. Estimated values are in millions of pounds. (NA indicates that insufficient data exists at this time to estimate the value)

Stock	MSST	MSY	OY range	MSY control rule
Adak red king	NA	1.5	0 - 1.5	0.2
Bristol Bay red king	44.8	17.9	0 - 17.9	0.2
Dutch Harbor red king	NA	NA	NA	0.2
Pribilof Islands red king	3.3	1.3	0 - 1.3	0.2
Norton Sound red king	NA	0.5	0 - 0.5	0.2
Pribilof Islands blue king	6.6	2.6	0 - 2.6	0.2
St Matthew blue king	11.0	4.4	0 - 4.4	0.2
St Lawrence blue king	NA	0.1	0 - 0.1	0.2
Aleutian Is. golden king	NA	15.0	0 - 15.0	0.2
Pribilof Is. golden king	NA	0.3	0 - 0.3	0.2
St. Matthew golden king	NA	0.3	0 - 0.3	0.2
Aleutian Is. scarlet king	NA	NA	NA	0.2
EBS scarlet king	NA	NA	NA	0.2
TOTAL king crab		**43.9**	**0 - 43.9**	
E. Aleutian Is. Tanner	NA	0.7	0 - 0.7	0.3
EBS Tanner	94.8	56.9	0 - 56.9	0.3
W. Aleutian Is. Tanner	NA	0.4	0 - 0.4	0.3
TOTAL Tanner crab		**58.0**	**0 - 58.0**	
EBS snow	460.8	276.5	0 - 276.5	0.3
TOTAL snow crab		**276.5**	**0 - 276.5**	
E. Aleutian Is. angulatus	NA	1.0	0 - 1.0	0.3
EBS angulatus	NA	0.3	0 - 0.3	0.3
E. Aleutian Is. tanneri	NA	1.8	0 - 1.8	0.3
EBS tanneri	NA	1.5	0 - 1.5	0.3
W. Aleutian Is. Tanneri	NA	0.2	0 - 0.2	0.3
TOTAL other Tanners		**4.8**	**0 - 4.8**	

Maximum sustainable yield (MSY) is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions. MSY is estimated from the best information available. Proxy stocks are used for BSAI crab stocks where insufficient scientific data exists to estimate biological reference points and stock dynamics are inadequately understood. MSY for crab species is computed on the basis of the estimated biomass of the mature portion of the male and female population or total mature biomass (MB) of a stock. A fraction of the *MB* is considered sustained yield (*SY*) for a given year and the average of the *SY*s over a suitable period of time is considered the MSY.

Overfishing: The term "overfishing" and "overfished" mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce MSY on a continuing basis. Overfishing is defined for king and Tanner crab stocks in the BSAI management area as any rate of fishing mortality in excess of the maximum fishing mortality threshold, F_{msy}, for a period of 1 year or more. Should the actual size of the stock in a given year fall below the minimum stock size threshold, the stock is considered overfished. If a stock or stock complex is considered overfished or if overfishing is occurring, the Secretary will notify the Council to take action to rebuild the stock or stock complex.

MSY control rule means a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY. The MSY control rule for king and Tanner crabs is the mature biomass of a stock under prevailing environmental conditions, or proxy thereof, exploited at a fishing mortality rate equal to a conservative estimate of natural mortality. SY in a given year is the MSY rule applied to the current spawning biomass. Overfishing occurs if the SY is exceeded for more that one year.

MSY stock size is the average size of the stock, measured in terms of mature biomass of a stock under prevailing environmental conditions, or a proxy thereof. It is the stock size that would be achieved under the MSY control rule. It is also the minimum standard for a rebuilding target when remedial management action is required. For king and Tanner crab, the MSY stock size is the average mature biomass observed over the past 15 years, from 1983 to 1997.

Maximum fishing mortality threshold (MFMT) is defined by the MSY control rule, and is expressed as the fishing mortality rate. The MSY fishing mortality rate F_{msy} = M, is a conservative natural mortality value set equal to 0.20 for all species of king crab, and 0.30 for all *Chionoecetes* species. If the harvest rate is greater than the MFMT, then overfishing is occurring.

Minimum stock size threshold (MSST) is one half the MSY stock size, or 50% of the B_{msy}. The minimum stock size threshold is expressed in terms of mature biomass of a stock under prevailing environmental conditions, or a proxy thereof. When the mature biomass falls below this level, the stock is considered overfished.

2.2 Tanner Crab

The FMP covers the Bering Sea stock of Tanner crab (*Chionocetes bairdi*). Amendment 11 is a rebuilding plan for the Bering Sea Tanner crab. On March 3, 1999, NMFS declared the Bering Sea stock of Tanner crab overfished because the stock size is below the minimum stock size threshold of 94.8 million pounds. The criteria for identifying when the fishery is overfished is explained in the Environmental Assessment for Amendment 7 (NPFMC 1998). As required by the Magnuson-Stevens Act, the Council developed and submitted a rebuilding plan to NMFS within one year from March 3, 1999. NMFS published in the **Federal**

Register a notice of approval for Amendment 11 on June 20, 2000 (65 FR 38216).

Abundance

The estimated abundance of Bering Sea Tanner crab was 64.2 million pounds of mature biomass in 1997, 36.9 million pounds in 1998, and 70.1 million pounds in 1999. The stock will be surveyed again in the summer of 2000. Figure 1 shows the mature biomass of Tanner crab from 1980-1999.

Distribution of Stock

Tanner crab are distributed on the continental shelf of the North Pacific Ocean and Bering Sea from Kamchatka to Oregon. Off Alaska, Tanner crab are concentrated around the Pribilof Islands and in Bristol Bay, and are found in lower abundance in the Gulf of Alaska.

In 1999, legal male Bering Sea Tanner crab were sparsely distributed in Bristol Bay and the Pribilof Islands, with the regions of highest abundance in central and southeast Bristol Bay. Distribution of the stock by year is detailed in the NMFS Reports to Industry on the Eastern Bering Sea Crab Surveys. Over the past 10 years, the regions of highest abundance have shifted around Bristol Bay, concentrating in years of low abundance in central, southeast, outer Bristol Bay. In years of high abundance, large males were widely distributed in Bristol Bay and continental slope areas with regions of relatively high abundance in mid-Bristol Bay or outer Bristol Bay and the Pribilof Islands.

Fishery

Approximately 250 vessels are qualified to fish Tanner crab under the Federal crab license limitation program. State regulations limit the number of pots a vessel can use - 250 pots for vessels >125 feet and 200 pots for vessels <125 feet.

The fishery targets male crabs larger than 5.5 inches (138 mm) carapace width. Bycatch in the Tanner crab fishery is sub-legal males and females and other species of crab. ADF&G developed gear modification requirements to reduce the bycatch. In the Bering Sea, a 3" maximum tunnel height opening for Tanner crab pots is required to inhibit the bycatch of red king crab. Escape rings were adopted by the Board in 1996 to reduce capture and handling mortality of non-target crab, including sub-legal and female Tanner crab. Other gear restrictions include a requirement that crab pots be fitted with a degradable escape mechanism to prevent ghost fishing if the pot is lost.

Catch and Harvest Rate

The guideline harvest level (GHL) is derived from the annual abundance estimates pre-season. ADF&G closed the fishery in 1997 due to low female abundance and it has remained closed because of low stock levels. Figure 1 shows the catch of Tanner crab and the years when the fishery is closed. As you can also see from Figure 1, stock abundance has fluctuated dramatically since 1980. The estimated spawning biomass of this stock is low and the stock is considered “overfished” under the Magnuson-Stevens Act. Over the past few decades, this stock appears to have experienced a 10-14 year recruitment cycle. The NMFS survey revealed high abundance of juvenile Tanner crabs in 1999, suggesting that an apparent strong recruitment event may soon promote stock rebuilding (NMFS 2000). Once the stock exceeds the fishery threshold for two consecutive years, fishing will be resumed, perhaps as soon as January 2002.

The rebuilding plan implements a conservative harvest strategy. ADF&G developed the stairstep harvest strategy for Tanner crabs, which was adopted by the Board in March 1999 and detailed in the ADF&G regional information report "Overview of Population Dynamics and Recommended Harvest Strategy for Tanner Crabs in the Eastern Bering Sea" (Zheng and Kruse 1999a). The new harvest strategy follows the precautionary approach to fishery management by incorporating a fishery threshold and stair-step harvest rates (Restripo et al. 1998). According to Zheng and Kruse (1999b), "These features reduce mature harvest rates to protect reproductive potential during periods of low abundance when risks of overfishing or falling below the overfished level reference points are high because of uncertainties in abundance estimates and population dynamics (i.e., depensation vs. compensation)."

The harvest strategy contains five components:

- Threshold: 21.0 million pounds of females biomass >79 mm CW. The fishery will be closed when the stock is below threshold.
- Mature Harvest Rates: 20% of molting mature males when biomass of females >79 mm CW is ≥45.0 million pounds and 10% of molting mature males when the biomass of females >79 mm CW is ≥21.0 million pounds and <45.0 million pounds. Molting mature males are 100% of newshell and 15% of oldshell males >112 mm CW.
- Legal Harvest Rate Cap: a 50% cap of exploitable legal males, which are 100% of newshell and 32% of oldshell legal males.
- GHLs for Bristol Bay and Pribilof Islands: GHLs are determined separately for crabs east of 168°W (Bristol Bay) and west of 168°W (Pribilof Islands) in the Eastern Subdistrict of the Bering Sea.
- A Precautionary Measure: when the stock is reopened to fishing after having been closed to all commercial fishing in the preceding season due to the depressed stock condition, the GHL in the season will be reduced to one-half of the value as computed in the above GHL determination.

Spatial and Temporal Distribution of Fishery

Map 2 shows the Tanner crab 10 year average harvest by State statistical area. This harvest area represents the distribution of large male crabs.

In March 2000, the Board adopted a seasonal management strategy for Bering Sea Tanner crab to create concurrent fisheries, reduce bycatch, and eliminate the possibility that the stock is hit twice. This strategy applies in years when the Tanner crab fishery is open (see harvest strategy above). East of 163°W long, Tanner crab is retained in the directed Bristol Bay red king crab (BBRKC) fishery until the fishery is closed or the Bristol Bay Tanner crab GHL is reached. Ten days after the closure of the BBRKC fishery, the area from 166°W long to 163°W long will be open to directed Tanner crab fishing gear until the Bristol Bay Tanner crab GHL is obtained or March 31. West of 166°W long, Tanner crab is retained in the directed snow crab fishery until the Pribilof Tanner crab GHL is obtained, the snow crab fishery closes, or March 31. In years when no GHL is established for the Bristol Bay red king crab stock or the snow crab stock, the Tanner crab fishery is restricted to the area west of 166° W long.

The Tanner crab season used to open November 1 and last until the GHL is harvested. Now, with the concurrent fisheries, in years when the fishery is open, Tanner crab will be harvested at three different times. East of 163°W long, the BBRKC and Tanner crab fishery will open October 15. Ten days after the closed of the BBRKC fishery, the area from 166°W long to 163°W long will be open to directed Tanner crab fishing gear until the Bristol Bay Tanner crab GHL is obtained or March 31. West of 166°W long, the snow crab and Tanner crab fishery will open January 15.

2.3 Snow crab

The FMP covers the fishery for the Bering Sea stock of snow crab (*C. opilio*). Amendment 14 is a rebuilding plan for Bering Sea snow crab. On September 24, 1999, NMFS declared the Bering Sea stock of snow crab crab overfished because the stock size is below the minimum stock size threshold of 460.8 million pounds. The Magnuson-Stevens Act requires the fishery management council to develop a rebuilding plan within one year from September 24, 1999. The criteria for identifying when the fishery is overfished is explained in the Environmental Assessment for Amendment 7 (NPFMC 1998).

Abundance

The estimated abundance of snow crab spawning biomass was 720.9 million pounds of mature biomass in 1998 and 283.5 million pounds in 1999. The stock will be surveyed again in the summer of 2000. Figure 2 shows the snow crab abundance from 1983 - 1999. As the figure shows, snow crab abundance is cyclical. Insufficient evidence exists to determine the cause of the snow crab decline. However, the evidence highly suggests the causes are natural. The crab fisheries only harvest the large male crabs, however, the 1999 NMFS trawl survey showed dramatic declines in all segments of population of these crabs. Furthermore, it was suggested that the reproductive capacity of these populations is related to the abundance or biomass of mature females, which are not affected to any great extent by the crab and groundfish fisheries. Recruitment for crab species appears to be linked to environmental factors rather than biomass, so trends in recruitment are difficult to predict.

A period of low recruitment is thought to be the reason for the decline in snow crab. These events are quite possibly triggered by corresponding events in the physical environment, such as the regime shift and warm Bering Sea conditions in 1997 and 1998. Temperature is likely to be important to snow crab population dynamics. Warmer temperatures hasten growth, but they likely have a negative effect on reproduction as faster growing males have fewer mating opportunities prior to attaining harvestable size. On the other hand, crab larvae feed primarily on copepod nauplii, which we think are favored by warmer water in the Bering Sea. Crab megalopa settle out of the water column at very specific temperatures and depths. Therefore, survival may be favored by cooler, warmer or intermediate temperatures depending on what life stage one considers. In 1997 and 1998, water temperatures were at record high levels, triggering unusual plankton blooms and contributing to salmon run failures. Beyond temperature, we suspect advection of larvae by ocean currents to the nursery areas and cannibalism within the limited nursery areas from older crab cohorts are contributors to recruitment success or failures.

Distribution of Stock

Snow crab are distributed on the continental shelf of the Bering Sea, Chukchi Sea, and in the western Atlantic as far south as Maine. In the Bering Sea, snow crab are common at depths between 50 and 200 meters. The eastern Bering Sea population within U.S. waters is managed as a single stock, however, the distribution of the population extends into Russian waters to an unknown degree. Off Alaska, C. opilio crab are distributed in the survey area from 55°N to 62°N deeper than 50 meters. Evidence exists that an unknown portion of female and juvenile snow crab are distributed north and west of the survey area.

In 1999, large male Bering Sea snow crab were highly concentrated north and east of the Pribilof Islands and south and west of St. Matthew Island. Distribution of the stock by year is detailed in the NMFS Reports to Industry on the Eastern Bering Sea Crab Surveys. In years of high abundance, large males also concentrate northwest of St. Matthew Island and between St. Matthew Island and the Pribilof Islands.

Fishery

The fishery targets male crabs larger than 4 inches carapace width, although the legal size is 3.1 inches (78 mm). State regulations limit the number of pots a vessel can use - 250 pots for vessels >125 feet and 200 pots for vessels <125 feet. Approximately 250 vessels are qualified to fish Tanner crabs (which includes *C. opilio*) under the crab license limitation program.

In the Bering Sea, a 3" maximum tunnel height opening for Tanner crab pots is required to inhibit the bycatch of red king crab. Escape rings were adopted by the Board in 1996 to reduce capture and handling mortality of non-target crab. Other gear restrictions include a requirement that crab pots be fitted with a degradable escape mechanism. In March 2000, the Board adopted gear requirements to reduce bycatch of sublegal males and females in the directed snow crab fishery.

Catch and Harvest Rate

The guideline harvest level (GHL) is derived from the annual abundance estimates pre-season. Prior to 1999, the status quo harvest rate was 58% of male crabs over 4 inches carapace width. Collapse of the Bering Sea snow crab stocks, as evidenced by severe lack of recruitment into the population, precipitated a reduction in the harvest rate to 22% for the 2000 snow crab fishery. Owing to the low spawning biomass (SB) of snow crab, NMFS classified the snow crab stock as "overfished" in 1999 and a rebuilding plan is being developed. The prospects for a 2001 fishery are uncertain. The rebuilding plan would implement a more conservative harvest strategy. ADF&G developed the stairstep harvest strategy for snow crabs, which was adopted by the Board in March 2000.

The harvest strategy contains five components:

- Exploitation rate applied to estimated biomass of mature males.
- Mature Harvest Rates: When the SB is ≥921.6 million pounds, the harvest rate is 22.5% of mature males. When the SB is ≥460.8 million pounds and <921.6 million pounds, the harvest rate is 16.875% of mature males. When the SB is ≥230.4 million pounds and <460.8 million pounds, the harvest rate is (SB/460.8)x16.875%. The fishery is closed when the SB is <230.4 million pounds.
- Legal Harvest Rate Cap: a 50% cap of exploitable legal males, which are 100% of newshell males ≥4" CW and 25% of oldshell males ≥4" CW.

Temporal and Spatial Distribution of Fishery

The snow fishery occurs in State Statistical area J, which includes all waters of the Bering Sea north of the latitude of Cape Sarichef at 54°36'N. lat. and east of the U.S. Russian Convention line of 1867. The snow crab fisheries occur in the Bering Sea in the U.S. EEZ from 56˚ N to 65˚N, concentrating between the 100 and 200 meter contour lines. Map 3 shows the 10 year average harvest of snow crab by location.

The fishing season opens January 15 and lasts until the GHL is harvested. In the past, the season has lasted through the middle of March. The 2000 snow crab fishery opened for one week on April 1. ADF&G delayed the season due to extensive sea ice covering a portion of the fishing grounds.

2.4 Blue King Crab

The FMP covers two stocks of blue king (*Paralithodes platypus*) crab, the St. Matthew stock and the Pribilof Island stock.

Amendment 15 is a rebuilding plan for St. Matthew blue king crab. On September 24, 1999, NMFS declared the St. Matthew blue king crab overfished because the stock size is below the minimum stock size threshold of 11 million pounds. The Magnuson-Stevens Act requires the fishery management council to develop a rebuilding plan within one year from September 24, 1999. The criteria for identifying when the fishery is overfished is explained in the Environmental Assessment for Amendment 7 (NPFMC 1999).

ADF&G closed the St. Matthews blue king crab fishery in 1999. It will remain closed until the stock size is above 2.9 million pounds of mature males. ADF&G also closed the fishery for the Pribilof Islands blue king crab due to low and declining legal male abundance and poor fishery performance, although the stock is not classified as overfished.

Abundance

The estimated spawning biomass of St. Matthew blue king crab was 24.1 million pounds in 1998 and 4.8 million pounds in 1999. The estimated spawning biomass of Pribilof Islands blue king crab was 10.7 million pounds in 1998 and 9.2 million pounds in 1999. Survey estimates for St. Matthew Island blue king crabs indicated dramatic declines of both male and female crabs in all size categories in 1999. Estimates of juvenile and female biomass are usually very imprecise due to the preference of such crab for rocky habitat which is not sampled well by trawls. Recruitment to the St. Matthew and Pribilof Islands blue king crab stocks has been declining for several years, but the sharp decline in all sizes suggest large survey measurement errors, a large increase in natural mortality, or some combination of both. The causes of the decline in recruitment into these blue king crab stocks in unknown, however, its presumed to be environmental. The stocks will be surveyed again in the summer of 2000. Figures 3 and 4 show the estimated abundance of these two stocks from 1980 to 1999.

Distribution of Stocks

Blue king crab has a discontinuous distribution throughout their range (Hokkaido, Japan to Southeast Alaska).

In the Bering Sea, discrete populations exist around St. Matthew Island, the Pribilof Islands, and St. Lawrence Island. Female and juvenile blue king crab are found in shallow water rocky habitat. Male blue king crab are found in waters around 70 meters.

Large male blue king crab were concentrated southeast of St. Matthew Island and northwest of the Pribilof Islands. Distribution of the stock by year is detailed in the annual NMFS Reports to Industry on the Eastern Bering Sea Crab Surveys.

Fishery

Minimum legal size for the Pribilof blue king crab is 6.5" carapace width. Approximately 143 vessels are qualified to fish in the Pribilof Island red and blue king crab concurrent fishery under the crab license limitation program. State regulations limit the number of pots a vessel can use - 50 pots for vessels >125 feet and 40 pots for vessels <125 feet.

Minimum legal size for St. Matthew Island blue king crab is 5.5" carapace width. Approximately 178 vessels are qualified to fish in the St. Matthew Islands red and blue king crab concurrent fishery under the crab license limitation program. State regulations limit the number of pots a vessel can use - 75 pots for vessels >125 feet and 60 pots for vessels <125 feet.

Other gear restrictions include a requirement that crab pots be fitted with a degradable escape mechanism. For the Pribilof district, king crab pots must have mesh webbing to reduce bycatch of small crab. For the St. Matthew district, to reduce bycatch of sub-legal and female crab, crab pots are required to have four 5.8 inch rings within one mesh of the bottom of the pot on each of 2 sides of the pot or one half of one side panel fit with 8 inch stretch mesh.

Catch and Harvest Rate

The GHL is derived from the annual abundance estimates and catch-survey analysis. The State generally sets pre-season GHLs for blue king crab based on a mature male harvest rate of 20%.

The rebuilding plan would implement a more conservative harvest strategy for St. Matthew blue king crab. ADF&G developed the stairstep harvest strategy for St. Matthew blue king crab, which was adopted by the Board in March 2000. Discussion and analysis of the harvest strategy, including the catch-survey analysis are in the ADF&G report "Overview of Stock Assessment and Recommended Harvest Strategy for St. Matthew Island Blue King Crabs" (Zheng and Kruse 2000).

The harvest strategy contains four components:

- Stock threshold: 2.9 million lbs of mature male (105 mm carapace length) biomass. This is 25% of the equivalent biomass at maximum sustainable yield (B_{msy}=11.6 million lbs).
- Minimum GHL: 2.5 million lbs.
- Directed mature harvest rates: 0.0 when mature male biomass (B) is <2.9 million lbs, equal to (B-2.9)/(8.7)*0.1+0.1 when 11.6 > $B \geq$ 2.9 million lbs, and 0.2 when $B \geq$ 11.6 million lbs, respectively.

- Cap of legal harvest rate: 0.4

Temporal and Spatial Distribution of Fishery

The blue king crab fishery occurs in the area of highest large male abundance, southwest of St. Matthew Island and north east of the Pribilof Islands (see Map 4 and Map 5).

Crab fishing is prohibited in the State waters (3 miles) around St. Matthew Islands and the nearby Pinnacle and Hall Islands to protect the egg-baring female and juvenile crab that congregate in the shallow waters and their habitat.

Season for the St. Matthew and Pribilof Islands blue king crab fisheries opens September 15 and lasts until the GHL is harvested, which is usually about a week.

2.5 Red King Crab

The FMP covers three stocks of red king crab (*Paralithodes camtschaticus*), the Bristol Bay stock, the Norton Sound stock, and the Pribilof Island stock.

In the past, Bristol Bay red king crab (BBRKC) fishery was closed due to low female abundance, the threshold established by ADF&G. Currently, however, the stock is healthy and supports a fishery.

The Norton Sound red king crab fishery is managed as a super-exclusive registration area separately from the rest of the BSAI crab fisheries. Vessels that fish for Norton Sound red king crab cannot fish in other crab fisheries (Lean and Brennan 2000). Likewise, vessels that fish in other crab fisheries cannot fish in Norton Sound.

The Pribilof Island red king crab stock is managed concurrently with the blue king crab stock. ADF&G closed the 1999 fishery for the Pribilof Islands blue and red king crab due to low and declining legal male abundance and poor fishery performance, although the stock is not classified as overfished.

Abundance

The estimated spawning biomass of Bristol Bay red king crab was 163.6 million pounds in 1998 and 117.7 million pounds in 1999. The estimate spawning biomass of Pribilof Islands red king crab was 7.4 million pounds in 1998 and 12.8 million pounds in 1999. These two stocks will be surveyed again in the summer of 2000. Figure 5 shows the estimated abundance of mature biomass and the catch from 1980 to 1999, as well as the status determination criteria for determining when the stock is overfished or overfishing is occurring.

The Norton Sound red king crab legal male abundance is estimated from the triennial trawl survey. The abundance estimate of legal male crabs in 1991 was 3.4 million pounds and in 1996 it was 1.6 million pounds. The survey conducted during August 1999 found a significant increase in the legal male population of red king crab to 4.3 million pounds.

The 1999 mature biomass estimates from the survey for Pribilof Islands red king crab was 12.8 million pounds. This is an increase from the 1998 mature biomass estimate of 7.4 million pounds. Despite an increase in 1999, survey and fishery data indicate a long-term decline in this stock. Figure 6 shows the estimated abundance of mature biomass and the catch from 1980 to 1999, as well as the status determination criteria for determining when the stock is overfished or overfishing is occurring.

Distribution of Stocks and Life History

Red king crab is widely distributed throughout the Bering Sea and Aleutian Islands, Gulf of Alaska, Sea of Okhotsk, and along the Kamchatka shelf. In Bristol Bay, red king crab mate when they enter shallower waters (<50 m), generally beginning in January and continuing through June. The female red king crab carries the eggs for 11 months before they hatch, generally in April. Red king crab spend 2-3 months in larval stages before settling to the benthic life stage. Young-of-the-year crab occur at depths of 50 m or less. They are solitary and need high relief habitat or coarse substrate such as boulders, cobble, shell hash, and living substrates such as bryozoans and stalked ascidians. Between the ages of two and four years, there is a decreasing reliance on habitat and a tendency for the crab to form pods consisting of thousands of crabs. Podding generally continues until four years of age (about 65 mm), when the crab move to deeper water and join adults in the spring migration to shallow water for spawning and deep water for the remainder of the year.

Fishery

Minimum legal size for red king crab is 6.5" carapace width. Approximately 263 vessels are qualified to fish in the Bristol Bay red king crab fishery under the crab license limitation program. State regulations limit the number of pots a vessel can use - 250 pots for vessels >125 feet and 200 pots for vessels <125 feet. Approximately 143 vessels are qualified to fish in the Pribilof Island red and blue king crab concurrent fishery under the crab license limitation program. State regulations limit the number of pots a vessel can use - 50 pots for vessels >125 feet and 40 pots for vessels <125 feet.

Other gear restrictions include a requirement that crab pots be fitted with a degradable escape mechanism. Also, for the Pribilof district, king crab pots must have mesh webbing to reduce bycatch of small crab.

Norton Sound: The legal size limit is ≥4.75 inches carapace width. The Norton Sound winter fishery uses snow machines to harvest crab. Approximately 10 snow machines are permitted to harvest king crab commercially. Approximately 32 vessels are permitted to fish in the summer king crab fishery. The pot limits in Norton Sound are 40 pots for vessels <125 feet and 50 pots for vessels >125 feet. A substantial subsistence fishery in the winter also exists for Norton Sound red king crab (Lean and Brennan 2000).

Catch and Harvest Rate

The GHL is derived from the annual abundance estimates and catch-survey analysis. The State generally sets pre-season GHLs for red king crab based on the following harvest strategy. ADF&G developed the stairstep harvest strategy for Bristol Bay red king crab. Analysis of the harvest strategy and the analytical tools used in developing and implementing the strategy are detailed in the ADF&G report: "Overview of population estimation methods and recommended harvest strategy for red king crabs in Bristol Bay" (Zheng et al. 1996).

The harvest strategy contains three components:

- the threshold level of abundance is 8.4 million mature female red king crab and 14.5 million pounds of effective spawning biomass[1]; the season will not open if preseason survey data indicates that the population is at or below either of these two indices of stock reproductive potential;
- if the effective spawning biomass is less than 55 million pounds, the harvest rate is 10% of mature male abundance or no more than 50% of the legal-sized male red king crab abundance, whichever is less;
- if the effective spawning biomass is 55 million pounds or more, the harvest rate is 15% of mature male abundance or no more than 50% of the legal-sized male abundance, whichever is less.

Pribilof Islands red king crab are harvested concurrently with the Pribilof Islands blue king crab fishery. The State generally sets pre-season GHLs for blue king crab based on a mature male harvest rate of 20%.

The Norton Sound GHL is set according to the following harvest strategy:
- when the abundance is below 1.5 million legal males crabs the fishery is closed;
- when the abundance is between 1.5 and 2.5 legal male crabs, the exploitation rate is 5% of legal male crabs; and
- when the abundance is above 2.5 million legal male crabs, the exploitation rate is 10% of legal male crabs.

Temporal and Spatial Distribution of Fishery

The Bristol Bay red king crab fishery occurs in State registration area T, between 56°N and 57°N latitudes and between 165°W and 161°W longitudes. Season for the Bristol Bay red king crab fisheries opens October 15 and lasts until the GHL is harvested, which is usually about a week. Prior to 1999, the fishery opened on November 1. Map 7 shows the Bristol Bay red king crab 10 year average harvest by location.

The Pribilof Islands red king crab fishery occurs in the area of highest large male abundance north east of the Pribilof Islands. The Pribilof Islands fishery opens September 15. Map 6 shows the Pribilof red king crab 10 year average harvest by location.

The Norton Sound fishery occurs in Norton Sound, concentrating near coastal villages. In 1981, the near shore waters were closed to commercial crab fishing. The Norton Sound fishery has 2 seasons, a winter season and a summer season. The winter season opens November 15 to May 15. The summer season is from July 1 to early September.

[1] "Effective spawning biomass" means the estimated biomass of mature female red king crab that the population of mature male red king crab could successfully mate in a given year.

2.6 Other king and Tanner crabs

Table 2. 1999/2000 Guideline harvest levels (GHL) and status of the fishery for BSAI king and Tanner crab stocks not annually surveyed. Estimated values are in millions of pounds. (NA indicates that insufficient data exists at this time to estimate the value)

Stock	GHL	Fishery/Season
Adak red king	0	closed
Dutch Harbor red king	0	closed
Norton Sound red king	??	7/1-9/3:11/15-5/15
St Lawrence blue king	NA	permit
Aleutian Is. golden king	5.7	9/1
Pribilof Is. golden king	0.15	permit
St. Matthew golden king	0.015	permit
Aleutian Is. scarlet king	NA	permit
EBS scarlet king	NA	permit
E. Aleutian Is. Tanner	0	closed
W. Aleutian Is. Tanner	0	closed
E. Aleutian Is. angulatus	NA	permit
EBS angulatus	NA	permit
E. Aleutian Is. tanneri	0.2	permit
EBS tanneri	0.2	permit
W. Aleutian Is. Tanneri	0.1	permit

The FMP covers other species of king and Tanner crabs in the BSAI, however, these species either do not support commercial fisheries or they support very small fisheries. These stocks are not annually surveyed by NMFS. Stock status for the following stocks is unknown due to no survey biomass estimates: Pribilof Islands golden king crab (*Lithodes aequispinus*); Saint Lawrence Island blue king crab; Northern District golden king crab; *C. bairdi* Tanner crab (Western Aleutian); Aleutian Islands Scarlet king crab (*Lithodes couesi*); Bering Sea triangle Tanner crab (*Chionoecetes angulatus*); Eastern Aleutian Islands triangle Tanner crab; Eastern Aleutian Islands grooved Tanner crabs (*Chionoecetes tanneri*); Western Aleutian Islands grooved Tanner crabs; Bering Sea grooved Tanner crabs.

The permit fisheries for the species identified in Table 2 are by ADF&G commissioner's permit only with observer requirements. Most of these species are generally taken as bycatch in other crab fisheries. The ADF&G Gulf of Alaska Marine Resource Assessment Survey is a triennial trawl survey east of 170°W that provides some information on Dutch Harbor red king crab, Aleutian Islands golden king crab, Aleutian Islands scarlet king crab, E. Aleutian Islands Tanner crab, and E. Aleutian Islands grooved crab. The 1999 survey results are not available yet.

Aleutian Islands red king crab (Dutch harbor and Adak red king crab stocks): The Adak stock has not been surveyed since 1977 and the eastern portion of the Dutch Harbor stock was surveyed in 1999 by Alaska Department of Fish and Game. Few red king crab were caught in either the 1995 or 1999 survey of the eastern Aleutians. The eastern portion has been closed since 1987. The western fishery was closed for the 1996/97 and 1997/98 seasons due to poor fishery performance in the 1995/96 season; portions were reopened to limited exploratory fishing for the 1998/99 season. The 1999/2000 season is closed. The GHL for the eastern portion is set based on the triennial-quadrennial trawl survey. GHLs for the western portion are based on recent fishery performance.

Aleutian Islands golden king crab (Eastern Aleutians (Dutch Harbor) and Adak golden (a.k.a. brown) king crab stocks): A portion of the eastern Aleutian Islands area was last surveyed with pots in 1997. The 1999/2000 GHL of 5.7 million pounds is divided into 2.7 million pounds west of 174°W, and 3.0 million pounds east of 174°W. The season opens August 15. The Aleutian Islands golden king crab stocks appear to be stable, based on the survey and fishery performance. Map 8 shows the 10 year average harvest in pounds by location in the Aleutian Islands golden king crab fishery. ADF&G requires 100% observer coverage on all vessels operating in this fishery.

Eastern Aleutian Islands *C. bairdi* Tanner crab: The fishery has been closed since 1995 due to declining stock size estimated from surveys and poor fishery performance. The 1995 ADF&G survey estimates of the number of crabs were 29,000 legal males and 135,000 females. The 1999 ADF&G survey estimate of crab abundance is not available at this time. However, preliminary survey results from 1999 indicate an increase in adult females and legal males from 1995 levels. Note that this increase is evident only within a very limited area.

2.7 Action Areas for the Crab Fisheries

The action area for BSAI crab fisheries effectively covers all of the Bering Sea under U.S. jurisdiction, extending southward to include the waters south of the Aleutian Islands west of 170°W long. to the border of the U.S. Exclusive Economic Zone. These regions encompass those areas directly affected by fishing, and those that are likely affected indirectly by the removal of crab at nearby sites. The lack of important information on distribution and stock structure of target species confounds a clear and precise definition of the action area, but a review of areas fished by the crab fisheries suggests that virtually the entire Bering Sea (from the continental slope shoreward) is utilized by one fishery or another.

2.8 Conservation measures associated with the crab fisheries

Crab fisheries are managed by ADF&G, NMFS and the Council in a manner intended to protect and conserve the integrity of these ecosystems. Fishery management tools include permits and limited entry, catch quotas (GHLs), seasons, in-season adjustments, gear restrictions, closed waters, bycatch limits and rates, allocations, regulatory areas, record keeping and reporting requirements, and observer monitoring. Annual management efforts are detailed below in the section on Federal fishery management actions (in the section on the environmental baseline).

3.0 Status of Protected Species

The following threatened and endangered species and designated critical habitat may be affected by the proposed actions:

Northern right whale	*Balaena glacialis*	Endangered
Bowhead Whale	*Balaena mysticetus*	Endangered
Blue whale	*Balaenoptera musculus*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Steller sea lion (western population)	*Eumetopias jubatus*	Endangered
Steller sea lion (eastern population)		Threatened

In the action areas, critical habitat has been designated only for the western and eastern populations of Steller sea lions (50 CFR 227.12).

The endangered short-tailed albatross (*Diomedea albatrus*), threatened spectacled eider (*Somateria fisheri*), and threatened Steller's eider (*Polysticta stelleri*) occur in the action areas for the three proposed actions; these species are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). In a letter dated January 13, 1998 from the USFWS to Steven Pennoyer, NMFS, Administrator, Alaska region, the USFWS concurred with NMFS's determination that the crab fisheries are not known to result in any significant impact to these seabirds. The listed salmon species are managed by the Northwest Region, NMFS, and will not be addressed further in this document as these species are not found in the action area.

3.1 Northern right whale

The following description of the northern right whale is summarized primarily from the Final Recovery Plan for the Northern Right Whale, *Eubalaena glacialis* (NMFS 1991a).

Species description and distribution

The northern right whale (*Eubalaena glacialis*) is a member of the order Cetacea, suborder Mysticeti, family Balaenidae. Stock structure in the North Pacific is unknown, although several different stocks have been hypothesized. Scarff (1986) suggests the possibility of a stock in the GOA.

Whaling records (Maury 1852, Townsend 1935) indicate the northern right whale ranged across the North Pacific above 35°N lat. In summer, they have been sighted north of the Bering Strait (Omura et al. 1969) and their distribution may have been continuous across the North Pacific south of the Aleutian Islands (Scarff 1986). The recovery plan for this species describes their distribution in the eastern North Pacific as follows:

> ". . . right whales historically summered in Alaska waters, mostly between 50° and 60°N from April or May to September, with a peak in sightings in coastal waters in June and July (Maury, 1852;

> Townsend, 1935; Omura, 1958; Klumov, 1962; Omura et al., 1969). Important historical concentration areas in Alaska appear to have been located in the Gulf of Alaska, especially south of Kodiak Islands (Rice and Wolman, 1982), and in the Eastern Aleutian Islands and southern Bering Sea shelf waters (Braham and Rice, 1984). They were particularly abundant in the Gulf of Alaska from 145° to 151°W (Berzin and Rovnin, 1966)."

Winter distribution patterns are unknown, but limited sightings have been made as far south as 27°N in the eastern North Pacific and near Hawaii. Migration patterns are essentially unknown, but presumably include southern movements to winter habitat and northern movements to summer habitat. Most recent sightings include observations of a group of 3-4 right whales (apparently including a juvenile animal) in western Bristol Bay on July 30, 1996 (Goddard and Rugh 1998). During July 1997, a group of 5-9 whales were observed in approximately the same location (C. Tynan, pers. comm., reported in Hill and DeMaster 1998), and aerial surveys in 1998 observed six whales in the same area (Marine Mammal Commission 1999).

Life history information

Essentially no information exists on reproduction or calving grounds in the eastern North Pacific. Based on the lack of sightings along the west coast of North America and around Hawaii, calving grounds may be offshore. Age distribution, mortality rates and sources of mortality (e.g., disease) are essentially unknown. Killer whales are suspected as possible predators, but no data are available to support this speculation (Scarff 1986).

Northern right whales feed at the surface on zooplankton (mainly copepods). They may compete with sympatric sei whales and many other predators or consumers of zooplankton in the eastern North Pacific and Bering Sea.

Population status and trends

Population dynamics of the northern right whale are unknown. The recovery plan for this species suggests that its pre-exploitation abundance was higher than 11,000, based on a known harvest of over 11,000 by U.S. whalers with additional numbers struck and lost (Brownell et al., 1986). Estimate of current population range from a low of 100-200 (Braham and Rice 1984) to a high of 220-500 (Berzin and Yablokov 1978 [in Berzin and Vladimirov 1981]), but Hill and DeMaster (1998) suggest a reliable estimate of abundance or trends is currently not possible. Population variability and stability are unknown, but population trends in the North Pacific may be influenced by factors affecting small populations (e.g., allee effects). No population projections have been made.

Listing status

Since 1949, the northern right whale has been protected from commercial whaling by the International Whaling Commission. In the U.S., northern right whales are listed as depleted under the Marine Mammal Protection Act and endangered under the Endangered Species Act. They are also listed in Appendix I of the Conservation on International Trade in Endangered Species of Wild Fauna and Flora. Critical habitat has not been designated for the northern right whale in the North Pacific.

3.2 Bowhead whale

Species description and distribution

Bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 54°N and south of 75°N in the western Arctic Basin (Braham 1984). The bowhead whale was historically found in all arctic waters of the northern hemisphere. Five stocks are currently recognized by the International Whaling Commission (IWC 1992). Three of these stocks are found in the North Atlantic and two in the North Pacific, some or all of which may be reproductively isolated (Shelden and Rugh 1995).

The Bering Sea stock of bowhead whales migrate annually from wintering areas (November to March) in the northern Bering Sea, through the Chuchi Sea in the spring (March through June), to the Beaufort Sea where they spend much of the summer(mid-May through September) before returning again to the Bering Sea in the fall (September through November) to overwinter (Braham et. al. 1980; Moore and Reeves 1993). The bowhead spring migration follows fractures in the sea ice around the coast of Alaska, generally in the shear zone between the shorefast ice and the mobile polar pack ice.

Life history information

Little is known regarding age at sexual maturity or mating behavior and timing for bowheads. It is assumed that mating takes place in late winter and spring (Koski et al. 1993), perhaps continuing through the spring migration (Ljungblad 1981; Koski et al. 1993). Most calves are born from April through early June during the spring migration, with a few calves born as early as March and as late as August (Koski et al. 1993). Calves are about 13 to 15 ft (4 to 4.5 m) at birth and reach 42 to 66 ft (13 to 20 m) as adults. Females produce a single calf, probably every 3 to 4 years (Koski et al. 1993).

Bowheads are filter-feeders, sieving prey from the water by means of baleen fibers in their mouth. They feed almost exclusively on zooplankton from the water column, with primary prey consisting of copepods (54%) and euphausiids (42%), as indicated from stomach analyses of whales taken in the Alaskan Beaufort Sea (Lowry 1993). Other prey include mysids, hyperiid and gammarid amphipods, other pelagic invertebrates, and small fish. Bowheads feed heavily in the Canadian Beaufort Sea and Amundsen Gulf area during summer and fall migration through the Alaskan Beaufort Sea (Alaska Clean Seas 1983; Ljungblad et al. 1987; Lowry, 1993). In surveys conducted from 1979 through 1987, concentrations of feeding bowheads were observed east of Point Barrow and just north of Harrison Bay (Ljungblad et al. 1987). However, a study on the importance of the eastern Beaufort Sea to feeding Bowhead whales indicated that, for this stock, food resources consumed there did not contribute significantly to the whales' annual energy needs (Richardson 1987). The Science Advisory Committee of the North Slope Borough identified certain deficiencies in this study, and additional research on the importance of the eastern Beaufort as feeding habitat is currently being done by the Minerals Management Service. Carbon isotope analysis of bowhead baleen has indicated that a significant amount of feeding may occur in wintering areas of the Chukchi and Bering Seas (Schell et. al. 1987; Schell 1998). The barrier islands all along the Beaufort Sea coast are considered by local residents an important resource to the bowhead whale for use as staging and feeding areas (M. Pederson in USACE 1996).

The summer distribution of bowheads within the Beaufort Sea is determined primarily by prey density and distribution, which in turn are responsive to variable current and upwelling patterns (LGL 1987). Sub-adult bowheads were observed to feed in water depths less than 164 ft (50 m) in the Canadian Beaufort Sea (Richardson et al. 1987). However, little is known about adult feeding behavior in the Canadian Beaufort.

Bowheads have extremely sensitive hearing. For example, they are capable of detecting sounds of icebreaker operations at a range of up to 31 miles (50 km) (Richardson 1996). It has been suggested that such sensitive hearing also allows whales to use reverberations from their low frequency calls to navigate under the pack ice and to locate open water polynyas where they surface (Ellison et al. 1987). Bowheads exhibit avoidance behavior at many manmade sounds, but there is still considerable debate regarding their range of sound detection (Richardson et al. 1995a). It is well known among Inupiat hunters that bowhead whales are extremely sensitive to noise (H. Rexford in USDOI, MMS 1979; R. Ahkivgak in NSB 1980; H. Ahsogeak in NSB 1980; T. Brower in NSB 1980; H. Brower in USDOI, MMS 1990). Communications among whales during migration and in response to danger also has been observed to alter migration patterns (A. Brower in USDOI, MMS, 1986; T. Napageak in USDOI, MMS, 1995). Whaling crews have observed that disturbances to migration as a result of a strike are temporary (J.C. George in USACE, 1996).

Generally, the vocalizations of bowhead whales are low, less than 400 hertz (Hz) frequency-modulated calls; however, their call repertoire also includes a rich assortment of amplitude-modulated and pulsed calls with energy up to at least 5 kilohertz (Wursig and Clark 1993). Calls and songs have been suggested to be associated with different contexts and whale behavior. Observations have been made that support the theory that calls are used to maintain social cohesion of groups. For instance, loud frequency-modulated calls were heard as a mother and a calf rejoined after becoming separated during summer feeding (Wursig and Clark 1993). Once the two were together again, calling stopped (Wursig and Clark 1993). During spring migration off Point Barrow, there have been several instances when individual whales repeatedly produced calls with similar acoustic characteristics (Clark et al. 1987). Bowhead whales have been noted to produce signature calls lasting for 3 to 5 minutes each and continuing up to 5 hours (Wursig and Clark 1993). Different whales produce signature calls as they counter call with other members of their herd. It has been suggested that calling among bowhead whales may aid in migration of the herd and that the surface reverberation of the sound off the ice may allow these whales to discriminate among areas through which they can and cannot migrate (Ellison et al.1987; Wursig and Clark 1993).

It has been speculated that bowheads are able to locate leads and open water along the marginal ice zone in winter by using acoustics (Moore and Reeves 1993). Although bowheads are morphologically adapted to their ice-dominated environment and can break holes in the ice to breathe, they may use vocalization to assess ice conditions in their path. For example, the intensity of reflected calls is as much as 20 decibels (dB) higher from ice floes with deeper keels than from relatively flat, thin ice (Ellison et al.1987). Bowheads may use such differences in intensity of reflected calls to differentiate between deep keel ice floes and flat, thin ice.

Bowhead whales have no known predators in the Bering Sea, except perhaps killer whales (*Orcinus orca*). Such attacks in the Bering Sea have occurred, but their frequency is reported as low. The frequency of attacks by killer whales in the Beaufort Sea is not well documented (George et al. 1994). Little is known about naturally occurring disease and death among bowhead whales. While certain viral agents are present in this stock, it is unknown how much they may contribute to natural mortality or reduced reproduction (Philo, et al. 1993).

Population status and trends

The Bering Sea stock of bowhead whales was reduced greatly by commercial whaling in the late 19th and early 20th centuries, from an estimated original population of 10,400 to 23,000 (Woodby and Botkin 1993) to a few thousand by about 1910. Whales taken by commercial whaling in the Bering Sea may have been representatives of a population that did not migrate (Bockstoce and Botkin 1983; Bockstoce 1986). Shore-based visual surveys conducted at Point Barrow from 1978 through 1983 yielded a population estimate for that period of about 3,500 to 5,300 animals (Zeh et al. 1993). The IWC Scientific Committee now recognizes the current population estimate to be 7,992 whales (95% C.I.: 6,900-9,200) (IWC 1995). A refined and larger sample of acoustic data from 1993 has resulted in an estimate of 8,200 animals and is considered a better estimate for this stock (Hill et al. 1997). An annual rate of increase of 3.1% was computed for the Bering Sea stock.

Bowheads are harvested by Inupiat in the Alaskan Beaufort, Bering, and Chukchi Seas. The total Alaskan subsistence harvest of bowheads between 1978 and 1991 ranged from 8 in 1982 to 30 in 1990, averaging 18 per year. In addition to the subsistence harvest, other man-induced impacts may contribute to morbidity and mortality. Commercial fishing occurs in the Bering Sea and elsewhere within the range of this stock. Interaction with fishing gear is rare, however whales with ropes caught in their baleen and with scarring caused by rope entanglement have been reported (Philo et al. 1993; NMML, unpubl. data). No incidental takes of bowheads have occurred in U.S. waters (Small and DeMaster 1995). George, et al. 1994 report three documented ship strike injuries observed among 236 bowheads taken in subsistence hunts. Man made noise in the marine environment is increasing with industrialization of the Alaskan arctic, and may impact these whales to an unknown degree. Presently there is insufficient evidence about cumulative and long-term effects of anthropogenic noises (Richardson and Malme 1993). Exposure to oil spills may have direct adverse consequences to bowheads, or predispose some whales to infection or injury.

Listing Status

The bowhead whale was listed as a Federal endangered species on June 2, 1970 (35 FR 8495). No critical habitat for this species has been designated within the action area.

3.3 Blue whale

The majority of the following description of blue whales comes from the Recovery Plan for the Blue Whale (*Balaenoptera musculus*) (NMFS 1998a).

Species description and distribution

Blue whales (*Balaenoptera musculus*) are members of the order Cetacea, suborder Mysticeti, family Balaenopteridae. The blue whale is essentially cosmopolitan in distribution (i.e., found in all major oceans). At least three subspecies have been designated, but only one of those (*B. m. musculus*) occurs in the northern hemisphere. The recovery plan for this species states:

> "It is assumed that blue whale distribution is governed largely by food requirements and that populations are seasonally migratory. Poleward movements in spring allow the whales to take advantage of high zooplankton production in summer. Movement toward the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting, avoid ice entrapment in some areas, and engage in reproductive activities in warmer waters of lower latitudes."

Within the North Pacific, the species is considered by the International Whaling Commission to be panmictic (Donovan 1991, Best 1993), but recent evidence suggests that blue whales in Alaskan waters are of a different stock than blue whales off California and Mexico (Rice 1992, Calambokidis et al. 1995, Gilpatrick et al. 1996, Barlow 1995, Calambokidis and Steiger 1995, NMFS 1998a). Again, from the recovery plan:

> "Whaling catch data indicate that animals believed to belong to the central stock (as defined by Gambell 1979) feed off the Aleutian Islands in summer. The prime period for blue whale catches (made in various years between 1912 and 1939) was June through August (Reeves et al. 1985). 'Discovery' tag returns indicate that this population ranges further to the east, with movements from the Gulf of Alaska to the Aleutian Islands, and from Vancouver Island to the Gulf of Alaska (Omura and Ohsumi 1964; Ohsumi and Masaki 1975; Ivashin and Rovnin 1967)."

In addition, analysis of catch records from 1929 to 1965 indicate separate western (off Kamchatka and the Kuril Islands) and central (the Aleutian Islands area) stocks (Forney and Brownell 1997). The recovery plan for the species concludes that there are five stocks in the North Pacific, two of which are relevant to this analysis: the central stock near the Aleutian Islands, and the eastern GOA stock. The north-south limits of these stocks appears to range from as far north as the Chukchi Sea (Yochem and Leatherwood 1985, Rice 1986a) to as far south as waters near Hawaii. They are found both over the continental shelf in coastal waters and far offshore in pelagic environments.

Life history information

Reproductive activities occur primarily in winter months. Gestation is 10-12 months, followed by a nursing period of about 6-7 months. Age of sexual maturity is unknown, but may be from 5 to 15 years (Mizroch et al. 1984a, Yochem and Leatherwood 1985). Age distribution is unknown, as are natural sources of mortality and mortality rates. Killer whales are known to attack blue whales, but the rate or significance of such attacks are unknown.

Euphausiids (*Euphasia pacifica* and *Thysanoëssa spinifera*) are thought to be the primary prey of blue whales in the North Pacific, but other prey have been reported including copepods and amphipods (Nemoto 1957, Nemoto and Kawamura 1977), pelagic red crabs (Rice 1974), small schooling fish, and squid (Mizue 1951, Sleptsov 1955).

Nemoto (1970) suggests that all sympatric baleen whales that consume euphausiids are potential competitors with blue whales. However, Clapham and Brownell (1996) suggest that little direct evidence exists for such competition and that the highly migratory behavior of blue whales would help them avoid such competition by allowing them to take advantage of widely dispersed prey resources.

Population status and trends

The recovery plan for this species indicates that the abundance of blue whales in the North Pacific can not be estimated reliably. The plan does include an estimate of about 3500 whales for the eastern North Pacific south of Oregon. It also notes evidence that the stocks in Aleutian waters and the GOA appear to remain depleted. In surveys of former Akutan whaling grounds in 1984 (Stewart et al. 1987) and south of the Aleutians in 1994 (Forney and Brownell 1997), no blue whales were sighted.

Listing status

Blue whales are listed as endangered under the ESA and depleted under the Marine Mammal Protection Act. The North Pacific stock is also listed as "low risk, conservation dependent" under the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has not been designated for the species.

3.4 Fin whale

The majority of the following descriptive information for the fin whale comes from the Draft Recovery Plan for the Fin Whale, *Balaenoptera physalus*, and Sei Whale, *Balaenoptera borealis* (NMFS 1998b).

Species description and distribution

Fin whales (*Balaenoptera physalus*) are members of the order Cetacea, suborder Mysticeti, family Balaenopteridae. They are cosmopolitan, or distributed widely in the world's oceans. Depending on food supply, fin whale groups may exhibit seasonal migration patterns to high latitudes in summer for feeding, and to low latitudes in winter, when they may be fasting. Other groups may remain in a particular area, depending on food supply. Mizroch et al. (1984b) described five feeding aggregations in the North Pacific. At present, however, NMFS considers stock structure in the North Pacific to be equivocal, and recognizes three stocks: 1) Alaska (Northeast Pacific), 2) California/Oregon/ Washington, and 3) Hawaii (Hill and DeMaster 1998).

The draft recovery plan for fin whales provided the following description of their distribution in the North Pacific:

> "Rice (1974) reported that the summer distribution of whales included 'immediate offshore waters' throughout the North Pacific from central Baja California to Japan and to as far north as the Chukchi Sea. They occurred in high densities in the northern Gulf of Alaska and southeastern Bering Sea from May to October, with some movement through the Aleutian passes into and out of the Bering Sea (Reeves et al. 1985). Fin whales were observed and taken by Japanese and Soviet whalers off eastern Kamchatka and Cape Navarin, both north and south of the eastern Aleutians, and in the northern Bering and southern Chukchi seas (Berzin and Rovnin 1966, Nasu 1974). . . . In recent years, fin whales have been observed . . . in summer and fall in the Gulf of Alaska (including Shelikof Strait) and southeastern Bering Sea (Leatherwood et al. 1986; Brueggeman et al. 1990). Their regular occurrence has also been noted in recent years around the Pribilof Islands in the northern Bering Sea (Baretta and Hunt 1994). . . . Fin whale concentrations in the northern North Pacific and Bering Sea generally form along frontal boundaries, or mixing zones between coastal and

oceanic waters, which themselves correspond roughly to the 200-m isobath (shelf edge)(Nasu 1974)."

Life history information

Reproductive activities occur primarily in winter months. Gestation is thought to be somewhat less than one year, followed by a nursing period of about 6-7 months. Age of sexual maturity may vary from six or seven to ten or more, depending on density-dependent factors (Gambell 1985b). Average calving interval is two or more years (Christensen et al. 1992). Pregnancy rates of adult females may range between 0.36 and 0.47 (Sigurjónsson 1995). Age distribution is unknown, but fin whale populations in the Gulf of Maine apparently included about 8% calves (as a percentage of total population; Agler et al. 1993). Sources and rates of natural mortality are largely underscribed, but Aguilar and Lockyer (1987) suggest annual natural mortality may range between 0.04 and 0.06. Killer whales are known to attack fin whales, and sharks are suspected of attacking young and sick whales.

Fin whales in the North Pacific feed on euphausiids, large copepods, and schooling fish such as herring, pollock, and capelin (Nemoto 1970, Kawamura 1982). Euphausiids may be preferred prey, and competition may occur with other baleen whales or other consumers of these prey types.

Population status and trends

The current status and trends of fin whales in the North Pacific, either in absolute terms or relative to pre-exploitation abundance, are unknown. Surveys in 1984 (Akutan whaling grounds, Stewart et al. 1987) and 1994 (south of the Aleutian Islands, Forney and Brownell 1996) observed no or few fin whales, respectively. In contrast, seabird surveys around the Pribilof Islands indicated an increase in local abundance of fin whales between 1975-78 and 1987-89 (Baretta and Hunt 1994).

Listing status

In the North Pacific, the IWC began management of commercial taking of fin whales in 1969, and fin whales were given full protection in 1976 (Allen 1980). The fin whale is listed as endangered under the ESA, depleted under the MMPA, and endangered under the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). The fin whale is also listed in Appendix I of CITES. Critical habitat has not been designated for the species.

3.5 Sei whale

The majority of the following descriptive information for the sei whale comes from the Draft Recovery Plan for the Fin Whale, *Balaenoptera physalus*, and Sei Whale, *Balaenoptera borealis* (NMFS 1998b).

Species description and distribution

Sei whales (*Balaenoptera borealis*) are members of the order Cetacea, suborder Mysticeti, family Balaenopteridae. They are cosmopolitan (Gambell 1985a, Horwood 1987), but tend to occur more over the deeper water of the continental slope and rarely enter inshore waters. They are relatively fast-moving and mobile, thought to be non-resident, and exhibit pole-ward seasonal migrations for feeding in summer and wintering in temperate or subtropical waters. Sei whales in the North Atlantic, North Pacific, and Southern Ocean are considered separate stocks. In the North Pacific, three stocks have been proposed, divided by longitudes 175°W and 155°W (Masaki 1977). The draft recovery plan for the species states:

> "In the North Pacific as a whole, the sei whale has been said to occur mainly south of the Aleutian Islands (Nasu 1974, Leatherwood et al. 1982) although Japanese sighting records presented by Masaki (1977) indicate concentrations in the northern and western Bering Sea from July through September. These data have never been confirmed and must be considered doubtful, as no other authority has ever reported them in the areas indicated. Horwood's (1987) synoptic evaluation of the Japanese sighting data led him to conclude that sei whales 'rarely penetrate deep into the Bering Sea.'"

Life history information

Reproductive activities occur primarily in winter. Rice (1977) estimated a gestation period of 12.7 months, an average calving interval of 3 years, and a mean age of sexual maturity of 10 years. These results differ somewhat from those proposed for the North Atlantic sei whale. Age structure is unknown. Rice (1977) also estimated total annual mortality for adult females as 0.088 and adult males as 0.103. Andrews (1916) suggested that killer whales attacked sei whales less frequently than fin and blue whales in the same areas.

Sei whales in the North Pacific are known to feed on euphausiids and copepods. The also feed higher up the food chain on squid and schooling fish, including Atka mackerel (Nemoto and Kawamura 1977). Rice (1977) suggested that the diverse diet of sei whales may allow them greater opportunity to take advantage of variable prey resources, but may also increase their potential for competition with commercial fisheries.

Population status and trends

Tillman (1977) suggested that the North Pacific population of sei whales declined from about 42,000 to 8,600 between 1963 and 1974. Current abundance or trends are not known.

Listing status

In the North Pacific, the IWC began management of commercial taking of sei whales in 1970, and fin whales were given full protection in 1976 (Allen 1980). The sei whale is listed as endangered under the ESA, depleted under the MMPA, and endangered under the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). The sei whale is also listed in Appendix I of CITES. Critical habitat has not been designated for the species.

3.6 Humpback whale

The majority of the following descriptive information for the humpback whale comes from the Final Recovery Plan for the Humpback Whale, *Megatera novaeangliae* (NMFS 1991b).

Species description and distribution

Humpback whales (*Megaptera novaeangliae*) are members of the order Cetacea, suborder Mysticeti, family Balaenopteridae. They are cosmopolitan in distribution, but less common in Arctic waters. They generally occur over continental shelves, shelf breaks, and around some oceanic islands (Balcomb and Nichols 1978, Whitehead 1987). They exhibit seasonal migrations between warmer temperate and tropical waters in winter and cooler waters of high productivity in summer. Summer ranges include "coastal and inland waters . . . from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk" (Tomlin 1967, Nemoto 1957, Johnson and Wolman 1984; all cited in NMFS 1991b).

In southeast Alaska, humpback whales are seen year-round, but are most common in May through December with peaks in late August and September. Distribution of whales in these inland waters appears to be determined primarily by distribution of their main prey, including herring and euphausiids. Individual whales may use the same feeding areas over many years.

Humpbacks also summer throughout the central and western portions of the GOA, including Prince William Sound, around Kodiak Island (including Shelikof Strait and the Barren Islands), and along the southern coastline of the Alaska Peninsula. The following description is taken directly from the recovery plan for this species.

> "In the 1960's, the waters south of the Alaska Peninsula were considered to be the center of the summer distribution of humpback whales in the North Pacific (Berzin and Rovnin 1966). Japanese scouting vessels continued to observe high densities of humpback whales near Kodiak Island during 1965-1974 (Wada 1980). In Prince William Sound, during recent years [i.e., prior to 1991], humpback whales have congregated near naked Islands, in Perry Passage, near Cheega island, in Jackpot, Icy and Whale Bays, in Port Bainbridge and north of Montague Islands between Green Island and the Needle (Hall 1979, 1982; von Ziegesar 1984; von Ziegesar and Matkin 1986). The few sighting of humpbacks in offshore waters of the centra Gulf of Alaska are usually attributed to animals migrating into coastal waters (Morris et al. 1983), although use of offshore banks for feeding is also suggested (Brueggeman et al. 1987)."

For the Aleutian Islands region and Bering Sea, the recovery plan states:

> "The waters along the continental shelf of the central Aleutian Islands were once considered the center of the North Pacific humpback whale population (Berzin and Rovnin 1966; Nishiwaki 1966). . . . Nikulin (1946) and Berzin and Rovnin (1966) described the northern Bering Sea, Bering Strait, and the southern Chukchi Sea along the Chukchi Peninsula as the northern extreme of the humpback's range. Within the Bering Sea, humpback whales were sighted with greatest frequency south of Nunivak Island and east of the Pribilof Islands (Berzin and Rovnin 1966; Braham et al. 1977; Nemoto 1978; Braham et al. 1982; Leatherwood et al. 1983)."

For the purposes of stock assessment, NMFS recognizes four management units in the North Pacific, two of which are pertinent to this consultation: one in the central North Pacific and one in the western North Pacific

(Hill and DeMaster 1998). The primary distinguishing pattern for these two management units is their wintering ground: the western North Pacific unit winters south of the Japanese archipelago, whereas the central North Pacific unit winters in the waters around Hawaii. The summer range of the western North Pacific unit is poorly studied, but almost certainly overlaps to some degree with that of the central North Pacific unit.

Life history information

Reproductive activities occur primarily in winter months. Sexual maturity occurs at age four to six, and the birth interval for mature females is every two to three years. Nursing occurs for up to 12 months. Annual pregnancy rates have been estimated at about 0.40-0.42 (NMFS unpublished and Nishiwaki 1959). Age distribution is unknown, but the portion of calves in various populations has been estimated at about 4-12% (Chittleborough 1965, Whitehead 1982, Bauer 1986, Herman et al. 1980, and Clapham and Mayo 1987). Sources and rates of natural mortality are generally unstudied, but potential sources of mortality include parasites, disease, predation (killer whales, false killer whales, and sharks), biotoxins, and ice entrapment.

Humpbacks exhibit a wide range of foraging behaviors, and feed on a range of prey types including small schooling fishes, euphausiids, and other large zooplankton. Fish prey in the North Pacific include herring, anchovy, capelin, pollock, Atka mackerel, eulachon, sand lance, pollack, Pacific cod, saffron cod, arctic cod, juvenile salmon, and rockfish. Invertebrate prey include euphausiids, mysids, amphipods, shrimps, and copepods.

Population status and trends

The best available estimate of population size for the western North Pacific unit is based on photo-identification studies conducted in 1991-93 (Calambokidis et al. 1997), and indicates an abundance of 394 (coefficient of variation = 0.084). Reliable information on trends are not available for this management unit. The best available estimate of population size for the central North Pacific management unit is based on the same photo-identification study during 1991-93, and indicates an abundance of 4,005 (coefficient of variation = 0.095) (Calambokidis et al. 1997).

The existing data are not sufficient to estimate trends for the western North Pacific management unit (Hill and DeMaster 1998). For the central North Pacific unit, the data are suggestive of an increasing trend, but are not sufficient to reliably estimate a rate of increase (Hill and DeMaster 1998).

For southcentral Alaska, the recovery plan states:

> ". . . recent [i.e., prior to 1991] studies suggest a dramatic reduction in the number and distribution of humpback whales in comparison to early records of commercial catches (Rice and Wolman 1982; Brueggeman et al. 1987; Hall 1979; von Ziegesar and Matkin 1986]. In Prince William Sound . . . annual use is variable and less than 100 individuals use this area during any given year (von Ziegesar and Matkin 1986). In the Shumagin Island region . . . Brueggeman et al. (1987) reported that humpback whales were generally found along shallow shelf breaks near islands and offshore banks. Although this distribution was similar to that reported in commercial whaling records, Brueggeman

> et al. (1987) reported some interesting exceptions. Extensive aerial surveys failed to find any humpback whales over the Davidson Bank, an area that was harvested regularly by the Akutan Whaling Station. a similar absence of humpback whales in the eastern Aleutian Islands is reported by Stewart et al. (1987). Brueggeman et al. (1987) attributed those absences to intensive exploitation of local herds and their failure to recover."

For the BSAI, the plan states:

> "Existing information on distribution in the Bering Sea and along the Aleutian Islands indicates a dramatic decline since commercial whaling commenced, but little evidence of any marked recovery since protection. Brueggeman et al. (1987) reported no sightings of humpback whales in the North Aleutian and St. George Basin OCS [Outer Continental Shelf] planning zones to the north and west of the Alaska Peninsula. Similarly, Stewart et al. (1987) reported that no humpback whales were observed during aerial surveys on or near areas hunted by vessels from the Akutan whaling station in the eastern Aleutians. Braham et al. (1977) saw 14 humpbacks in the northern Bering Sea in August 1976, and Braham et al. (1982) documented 25 humpbacks between 1958-1978 in the southern Bering Sea between Unimak Pass and the Pribilof Islands."

Listing status

The humpback whale in the North Pacific was first protected by the IWC in 1965. The humpback was classified as endangered when the ESA was passed in 1973. Critical habitat has not been designated for the species.

3.7 Sperm whale

Species description and distribution

The sperm whale (*Physeter macrocephalus*) is a member of the order Cetacea, suborder Odontoceti, family Physeteridae. The species has a cosmopolitan distribution. In the North Pacific, they are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. As they inhabit deeper pelagic waters, their distribution does not include the broad continental shelf of the EBS, and these whales generally remain offshore in the eastern Aleutian Islands and GOA. Distribution also varies as a function of sex and social status, with females and young remaining further south in temperate and tropical waters, and males moving north in summer to feed in the Bering Sea, around the Aleutian Islands, and in the GOA. During winter, their distribution is generally south of 40°N latitude (Gosho et al. 1984), but seasonal movements are have not been described (Hill and DeMaster 1998). For stock assessment purposes, NMFS has divided the North Pacific population into three stocks, only one (the Alaska or North Pacific stock) of which is considered relevant to this consultation.

Life history information

Both males and females are thought to reach sexual maturity at approximately 10 years of age. However, males may not reach social maturity (i.e., sufficient size to compete for breeding rights) for another decade.

The gestation period is about 15 months, and nursing continues for two to three years. The interbirth interval is, therefore, on the order of three to four years. Age distribution is unknown; longevity may be seventy years or more. Sources and rates of mortality are unknown.

Sperm whales are known for their deep foraging dives (in excess of 3 km). The feed primarily on mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Tarasevich 1968, Berzin 1971). Perez (1990) estimated that their diet in the Bering Sea was 82% cephalopods (mostly squid) and 18% fish. Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish, Pacific cod, pollock, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey, skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986b).

Population status and trends

Current estimates for population abundance, status, and trends for the North Pacific stock are not available or are considered unreliable (Hill and DeMaster 1998).

Listing status

Sperm whales are listed as endangered under the ESA and depleted under the MMPA. They have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). A recovery plan has not been prepared for the species; nor has critical habitat been designated. The primary threat to the species has been commercial whaling.

3.8 Steller sea lion

A complete discussion of the Steller sea lion is contained in the Biological Opinion on 2000 TAC Specifications for BSAI and GOA Groundfish Fisheries, and the AFA (NMFS 1999). By reference, this document is incorporated in this document in its entirety.

Species description

The Steller sea lion (*Eumetopias jubatus*) is the only extant species of the genus *Eumetopias*, and is a member of the subfamily Otariinae, family Otariidae, superfamily Otarioidea, order Pinnipedia. The Steller sea lion is distributed around the North Pacific rim from the Channel Islands off Southern California to northern Hokkaido, Japan. The species' distribution extends northward into the Bering Sea and along the eastern shore of the Kamchatka Peninsula. The center of distribution has been considered to be in the GOA and the Aleutian Islands (NMFS 1992).

Within this distribution, land sites used by Steller sea lions are referred to as rookeries and haulout sites. In the Bering Sea, the northernmost major rookery is on Walrus Island (Pribilof Islands) and their northernmost major haulout is on Hall Island (off the northwestern tip of St. Matthew Island). Rookeries are used by adult males and females for pupping, nursing, and mating during the reproductive season (late May to early July). Haulouts are used by all size and sex classes but are generally not sites of reproductive activity as occurs on rookeries. The continued use of particular sites may be due to site fidelity, or the tendency of sea lions to return repeatedly to the same site, often the site of their birth. Presumably, these sites were chosen and continue to be used because of their substrate and terrain, the protection they offer from terrestrial and marine predators, protection from severe climate or sea surface conditions, and (perhaps most importantly) the availability of prey resources.

The movement patterns of Steller sea lions are not yet well understood. Their movement patterns from a land base (rookery or haulout) might be categorized into at least three types. First, sea lions move on and offshore for feeding excursions. Limited data are available to describe these movements (e.g., Gentry 1970, Sandgren 1970, Merrick and Loughlin 1997), but such descriptions are essential for understanding foraging patterns, nursing strategies, and energetics. Second, at the end of the reproductive season, some females may move with their pups to other haulout sites and males may "migrate" to distant foraging locations [Spaulding 1964, Mate 1973, Porter 1997]). Limited data are available indicating that animals do shift from rookeries to haulouts, but the timing and nature of these movements need further description (i.e., what distances are involved, are movements relatively predictable for individuals, do movements vary with foraging conditions, etc.). Description of these types of movements are essential for understanding seasonal distribution changes, foraging ecology, and apparent trends as a function of season. Third, sea lions may make semi-permanent or permanent one-way movements from one site to another (Chumbley *et al*. 1997, their Table 8; Burkanov *et al*. unpubl. report [cited in Loughlin 1997]). Calkins and Pitcher (1982) reported movements in Alaska of up to1500 km. They also describe wide dispersion of young animals after weaning, with the majority of those animals returning to the site of birth as they reach reproductive age.

The distribution of Steller sea lions at sea is also not well understood. Their at-sea distribution is, however, a critical element to any understanding of potential effects of fisheries on Steller sea lions, and will be considered in greater detail below in the section on foraging patterns.

Reproduction

Steller sea lions have a polygynous reproductive system where a single male may mate with multiple females. As mating occurs on land (or in the surf or intertidal zones), males are able to defend territories and thereby exert at least partial control over access to adult females and mating privileges. The pupping and mating season is relatively short and synchronous, probably due to the strong seasonality of the sea lions' environment and the need to balance aggregation for reproductive purposes with dispersion to take advantage of distant food resources (Bartholomew 1970). In May, adult males compete for rookery territories. In late May and early July, adult females arrive at the rookeries, where pregnant females give birth to a single pup. The sex ratio of pups at birth is assumed to be approximately 1:1 (e.g., York 1994) or biased toward slightly greater production of males (e.g., Pike and Maxwell 1958, Lowry *et al*. 1982, NMFS 1992).

Mating occurs about one to two weeks later (Gentry 1970). The gestation period is probably about 50 to 51 weeks, but implantation of the blastocyst is delayed until late September or early October (Pitcher and Calkins 1981). Due to delayed implantation, the metabolic demands of a developing fetus are not imposed until well after fertilization.

For females with a pup, the nursing period continues for months to several years. The transition to nutritional independence may occur over a period of months as the pup begins to develop essential foraging skills, and depends less and less on the adult female. The length of the nursing period may also vary as a function of the condition of the adult female. The nature and timing of weaning is important because it determines the resources available to the pup during the more demanding winter season and, conversely, the demands placed on the mother during the same period. The maintenance of the mother-offspring bond may also limit their distribution or the area used for foraging.

Relatively little is known about the life history of sea lions during the juvenile years between weaning and maturity. Pitcher and Calkins (1981) reported that females sampled in the late 1970s reached reproductive maturity between ages 2 and 8, and the average age of first pregnancy was 4.9 ±1.2 years. These results suggest a mean age of first birth of about 6 years. The available literature indicates an overall reproductive (birth) rate on the order of 55% to 70% or greater (Pike and Maxwell 1958, Gentry 1970, Pitcher and Calkins 1981, Pitcher *et al*. in review).

The reproductive cycle includes mating, gestation, parturition, and nursing or post-natal care. The reproductive success of an adult female is determined by a number of factors within a cycle and over time through multiple cycles. The adult female's ability to complete this cycle successfully is largely dependent on the resources available to her. While much of the effort to explain the Steller sea lion decline has focused on juvenile survival rates, considerable evidence suggests that the decline may also be due, in part, to decreased reproductive success.

Males appear to reach sexual maturity at about the same time as females (i.e., 3 and 7 years of age; Perlov 1971 reported in Loughlin *et al*. 1987), but generally do not reach physical maturity and participate in breeding until about 8 to 10 years of age (Pitcher and Calkins 1981). A sample of 185 harem bulls from the Marmot, Atkins, Ugamak, Jude, and Chowiet Islands in 1959 included animals 6 to 17 years of age, with 90% from 9 to 13 years old (Thorsteinson and Lensink 1962).

Survival

Much of the recent effort to understand the decline of Steller sea lions has been focused on juvenile survival, or has assumed that the most likely proximate explanation is a decrease in juvenile survival rates. This contention is supported by direct observations and a modeling study, and is consistent with the notion that juvenile animals are less adept at avoiding predators and obtaining sufficient resources (prey) for growth and survival.

However, juvenile survival may not be the only factor influencing the decline of the western population of Steller sea lions. Evidence indicating a decline in reproductive success was presented in the previous section. In addition, changes in adult survival may also have contributed to the decline. At present, survival rates for adult animals can not be determined with sufficient resolution to determine if those rates have changed over time or are somehow compromised to the extent that population growth and recovery are compromised.

Foraging patterns

At present, our understanding of Steller sea lion foraging distribution is based on sightings at sea or observations of foraging behavior (or presumed foraging behavior) in areas such as the southeastern Bering Sea (Fiscus and Baines 1966, Kajimura and Loughlin 1988, NMFS unpublished data from the Platform-of-Opportunity Program [POP]), records of incidental take in fisheries (Perez and Loughlin 1991), and satellite telemetry studies (e.g. Merrick *et al*. 1994, Merrick and Loughlin 1997). Observations and incidental take of sea lions (Loughlin and Nelson 1986, Perez and Loughlin 1991) in the vicinity of Seguam Pass, the southeastern Bering Sea, and Shelikof Strait provided a basis for establishment of those areas as critical habitat (58 FR 45269).

The POP database provides our best overall view of the foraging range or distribution of Steller sea lions (Fig. 13). However, this database should be viewed with some caution. Nevertheless, this database and the locations of sea lions taken incidentally in groundfish fisheries (1973-1988, Perez and Loughlin 1991), indicate that sea lions disperse widely to forage throughout much of the Bering Sea and the GOA, at least as far out as the continental shelf break. Such broad dispersal may be essential to sea lion populations to take advantage of distant food resources and, as a consequence, limit intra-specific competition near rookeries and haulouts.

The results of limited telemetry studies suggest that foraging distributions vary by individual, size or age, season, site, and reproductive status (i.e., is the female still supporting a pup; Merrick and Loughlin 1997). The foraging patterns of adult females differed during summer months when females were with pups versus winter periods when considerable individual variation was observed, but may be attributable to the lactation condition of the females. Trip duration for females (n = 14) in summer was approximately 18 to 25 hours. For five of those females that could be tracked, trip length averaged 17 km and they dove approximately 4.7 hours per day. For five females tracked in winter months, mean trip duration was 204 hours, mean trip length was 133 km, and they dove 5.3 hours per day. The patterns exhibited by females in winter varied considerably, from which the investigators inferred that two of them may still have been supporting a pup. Those two females continued to make relatively shorter trips (mean of 53 km over 18 hours) and dove 8.1 hours per day, whereas the other three ranged further, dove 3.5 hours per day, and spent up to 24 days at sea. Five winter young-of-the-year exhibited foraging patterns intermediate between summer and winter females in trip distance (mean of 30 km), but shorter in duration (mean of 15 hours), and with less effort devoted to diving (mean of 1.9 hours per day). Estimated home ranges (mean ± 1 SE) were 319 ± 61.9 km^2 for adult females in summer, 47,579 ± 26,704 km^2 for adult females in winter, and 9,196 ± 6799 km^2 for winter young-of-the-year.

Overall, the available data seem to suggest two types of foraging patterns: 1) foraging around rookeries and haulouts and that is crucial for adult females with pups, pups, and juveniles, and 2) foraging that may occur over much larger areas where these and other animals may range to find the optimal foraging conditions once they are no longer tied to rookeries and haulouts for reproductive or survival purposes.

Foraging depths

The sea lions in the Merrick and Loughlin (1997) study tended to make relatively shallow dives, with few dives recorded at greater than 250 m. Maximum depth recorded for the five summer adult females were in the range from 100 to 250 m, and maximum depth for the five winter adult females was greater than 250 m. The maximum depth measured for winter young-of-the-year was 72 m. These results suggest that sea lions are generally shallow divers, but are capable of deeper dives (i.e., greater than 250 m).

The instruments used to record diving depths do not determine the purpose of a dive, and many of the recorded dives may not be indicative of foraging effort. Dives between 4 and 10 m depth may be for foraging, or they may be related to other behaviors such as social interactions or transiting between locations. For example, animals transiting to and from foraging locations during rough sea surface conditions may transit in a series of long, shallow dives to avoid such conditions. The relatively large number of dives recorded between 4 and 10 m may therefore bias the assessment of "foraging" depths for these sea lions.

The results from this study also may not be indicative of diving depths and patterns for other sea lions at other times of year or in other locations. The winter young-of-the-year were instrumented in the period from November to March, when they were probably about five to nine months old and may have still been nursing. At this age, they are just beginning to develop foraging skills, which may take years to learn. The diving depths and patterns exhibited by these young-of-the-year are likely poor indicators of the foraging patterns of older juveniles (one- to three-year-olds). Clearly, if young-of-the-year are limited to relatively shallow depths, and older animals are capable of diving to much greater depths, then those younger animals are just beginning to develop the diving and foraging skills necessary to survive. The rate at which they develop those skills and, for example, begin to dive to greater depths or take prey at greater depths, is unknown, but probably occurs rapidly after weaning to take advantage of otherwise unavailable prey resources.

Prey, energetics and nutrition, and diversity

At the least, an understanding of Steller sea lion foraging requires a listing of their prey species, a qualitative or (preferably) quantitative measure of the relative importance of different prey types, descriptions of prey characteristics and predator-prey dynamics, and an assessment of diet diversity. A (partial) listing of Steller sea lion prey species or prey types would include (not in order of priority): Atka mackerel, capelin, crabs, dogfish sharks, eulachon, flatfish, greenling, hake, halibut, herring, lamprey, lingcod, molluscs, octopus, Pacific cod, pollock, ratfish, rockfishes, salmon, sand lance, sculpins, shrimps, smelt, squid, and yellowfin sole.

Qualitative or quantitative indices of prey importance might be developed on the basis of prey "selection" or "preference." However, we rarely have information on the distribution or availability of different prey types, and therefore don't have a basis for inferring "selection" or "preference" (Lowry *et al*. 1982, Frost and Lowry 1986). In most studies of Steller sea lion prey, rank frequency of occurrence is used as a qualitative (or semi-quantitative) index of relative importance. More quantitative estimation of the importance of different prey types is considerably more difficult. The value of a prey type should be quantified on the basis of the observed net gain in calories and nutrients resulting from predation on that prey type versus other prey types. Such a determination would require information on biomass consumed, caloric and nutrient content of that biomass, energy and nutrients gained, and energy and nutrients expended (i.e., the costs of predation). Caloric and nutrient content of different prey types are relatively easy to determine using proximate analysis, although Stansby (1976) cautioned that individuals of the same prey type may vary considerably as a function of season, site, reproductive condition, and other factors. Biomass consumed and costs of predation are more difficult to quantify, particularly with respect to any particular prey type. Many of the studies on Steller sea lion foraging patterns provide information on frequency of occurrence, but such information cannot be readily converted into biomass consumed unless additional data are provided. Biomass estimates are more readily determined from volumetric measurements of stomach contents, but can also be estimated from length-weight relationships combined with measured lengths of prey or estimated length at age (with age based on otoliths; e.g., Frost and Lowry 1986). Costs of predation may also vary considerably by prey type, depending on the distribution, life history characteristics, and behavior of the prey.

Important prey characteristics include their tissue or body composition, individual size (mass), availability, depth in the water column, their degree of association with the bottom, their reproductive behaviors, their degree of aggregation (e.g., solitary versus schooling), and their temporal and spatial distribution patterns. To date, the limited telemetry information available indicates that sea lions generally forage at depths less than 250 m. However, the available evidence from the POP database indicates that sea lions are commonly sighted (and presumably foraging) in the vicinity of the continental shelf break. If sea lions in the vicinity of the shelf break are diving to depths near the bottom, then depths of 200 m to 250 m may be more indicative of common or modal dives than extremes of their diving range. And many sea lion prey are, at one life stage or another, associated with the bottom. Predation on prey associated with the bottom is a common pinniped strategy, perhaps because the bottom limits the spatial dimensionality of the predator-prey arena and thereby limits the prey's alternatives for escape. Male Atka mackerel, for example, may be susceptible to predation because they fertilize and then guard eggs laid by the female on the bottom. Schooling behavior of prey probably enhances their value, as such schooling may increase sea lion consumption relative to costs associated with searching and capture.

The spatial and temporal distributions of prey types is a critical determinant of their availability to sea lions. The consistent pattern of the Atka mackerel fishery over time indicates that aggregations of Atka mackerel are distributed in patches that are relatively predictable. Aggregations of pollock are less predictable in time and space than aggregations of Atka mackerel, but also demonstrate considerable predictability, particularly for winter and spring spawning aggregations. The availability and characteristics of prey patches (pollock, Atka mackerel, Pacific cod, or other prey) may be essential to the foraging success of sea lions. Important patch characteristics may include their size, location, persistence, composition (e.g., prey sizes) and density (number of patches per area). Unfortunately, the information available to characterize such prey patches (and evaluate their potential importance to sea lions) is limited to trawl and hydroacoustic surveys that generally provide a single broad-scale snapshot of prey distribution on an annual or less frequent basis.

The quality of the sea lion diet appears to be determined not only by the individual components (species) of the diet, but also by the mix or diversity of prey in the diet. Merrick *et al*. (1997) found a correlation between a measure of diet diversity in different geographic regions of the western population and population trends in those regions. Their conclusions were that reliance on a single prey type may not be conducive to population growth; a diversity of prey may be necessary for recovery of the western population. Trites (unpubl. data) evaluated the diet and population growth data for Steller sea lions in southeast Alaska and found results consistent with those of Merrick *et al.* (1997). Unfortunately, diet diversity is a function not only of prey selection, but of the diversity of prey available. Regardless of the diversity of the prey field available, sea lions must survive on those prey.

Foraging - integration and synthesis

While much remains to be learned about Steller sea lions, the available information is sufficient to begin a description of their foraging patterns. The emerging picture appears to be that:

- Steller sea lions are land-based predators but their attachment to land and foraging patterns/distribution may vary considerably as a function of age, sex, site, season, reproductive status, prey availability, and environmental conditions;

- Steller sea lions tend to be relatively shallow divers but are capable of (and apparently do) exploit deeper waters (e.g., to beyond the shelf break);

- at present, pollock and Atka mackerel appear to be their most common or dominant prey, but Steller sea lions consume a variety of demersal, semi-demersal, and pelagic prey;

- diet diversity may influence status and growth of Steller sea lion populations;

- the life history and spatial/temporal distribution of important prey species are likely important determinants of sea lion foraging success;

- foraging sites relatively close to rookeries may be particularly important during the reproductive season when lactating females are limited by the nutritional requirements of their pups; and

- the broad distribution of sea lions sighted in the POP database indicates that sea lions also forage at sites distant from rookeries and haulouts; the availability of prey at these sites may be crucial in that they allow sea lions to take advantage of distant food sources, thereby mitigating the potential for intraspecific competition for prey in the vicinity of rookeries and haulouts.

The question of whether competition exists between the Steller sea lion and BSAI fisheries is a question of sea lion foraging success. For a foraging sea lion, the net gain in energy and nutrients is determined, in part, by the availability of prey or prey patches it encounters within its foraging distribution. Competition occurs if the fisheries reduce the availability of prey to the extent that sea lion condition, growth, reproduction, or survival are diminished, and population recovery is impeded. The question of whether competition occurs will be addressed in the "effects of the action" section below.

Natural predators

The Recovery Plan for the Steller Sea Lion (NMFS 1992) states: "Steller sea lions are probably eaten by killer whales and sharks, but the possible impact of these predators is unknown. The occurrence of shark predation on other North Pacific pinnipeds has been documented, but not well quantified (Ainley *et al*., 1981)." The likelihood of shark attack is probably greater for Steller sea lions off the Washington, Oregon, and California coasts than in waters further north. A killer whale attack has been documented off the Oregon coast (Mate 1973), but killer whales are probably much more frequent predators in the waters of British Columbia and Alaska (Barrett-Lennard *et al*., unpubl. rep.). Barrett-Lennard *et al*. (unpubl. rep.) model sea lion mortality due to killer whales, and suggest that while such predation may account for a significant portion of natural mortality at the current low size of the sea lion population, it was not likely to have been the cause of the decline. The most recent status report on Steller sea lions (NMFS 1995) concurs and points out that relative abundance of killer whales is likely greater off southeast Alaska, where sea lion populations have been slowly increasing.

Since the completion of the December 3, 1998 Biological Opinion on the possible effects of the pollock and Atka mackerel fisheries on the western population of Steller sea lions, a number of killer whale and sea lion interactions have been reported throughout the GOA and BSAI regions. Such interactions might reflect a true increase in such interactions, increased reporting of a relatively constant level of interactions, or some combination of the two. Without further scientific study of such interactions, the significance of killer whale predation to the status and trends sea lion populations can not be determined with confidence.

Natural competitors

Competition may take several forms. For exploitative competition to occur, the potential competitors must utilize the same resource, the availability of that resource must be limited relative to the needs of the potential competitors, and use of the available resource by one of the potential competitors must impede use by the other (Krebs 1985). Interference competition can occur even when resources are not limited if the use of the resource by one potential competitor harms another. With respect to other (nonhuman) species, Steller sea lions are most likely to compete with for food, although they may also compete for habitat (e.g., potential competition with northern fur seals for rookery or haulout space).

Steller sea lions forage on a variety of marine prey that are also consumed by other marine mammals (e.g., northern fur seals, harbor seals, humpback whales), marine birds (e.g., murres and kittiwakes), and marine fishes (e.g., pollock, arrowtooth flounder). To some extent, these potential competitors may partition the prey resource so that little direct competition occurs. For example, harbor seals and northern fur seals may consume smaller pollock than Steller sea lions (Fritz *et al*. 1995). Competition may still occur if the consumption of smaller pollock limits the eventual biomass of larger pollock for sea lions, but the connection would be difficult to demonstrate. Such competition may occur only seasonally if, for example, fur seals migrate out of the area of competition in the winter and spring months. Similarly, competition may occur only locally if prey availability or prey selection varies geographically for either potential competitor. Finally, competition between sea lions and other predators may be restricted to certain age classes, as diet may change with age or size.

Disease

While a range of different parasites, diseases, and maladies have been documented for Steller sea lions, the available evidence is not sufficient to demonstrate that these have played or are playing any significant part in the decline of the western population.

Population dynamics

The breeding range of the Steller sea lion covers virtually all of the North Pacific Rim from about 34° N to 60°N lat. Within this range, sea lions are found in hundreds of rookeries and haulouts. These rookery and haulout sites are frequently grouped into rookery/haulout clusters on the basis of politics, geography, demographic patterns, genetics, foraging patterns, or other reasons related to scientific study or management. Political divisions are drawn to separate animals that are found off Japan or the Republic of Korea, in Russian territories, in Alaska, British Columbia, or along the western coast of Washington, Oregon, and California. These divisions are largely for the purpose of management or jurisdiction, but may be related to sea lion population dynamics because of differing management strategies or objectives.

Geographic distinctions are frequently made on the basis of variable habitat or ecosystem characteristics in differing parts of the range. For example, rookeries and haulouts in the Aleutian Islands are often separated from those in the GOA, and these two areas are again separated from southeastern Alaska and British Columbia. These distinctions may have demographic significance because of the important variability in ecosystem features such as prey resources.

Sea lion rookeries and haulouts are also grouped on the basis of observed demographic trends (York *et al*. 1996). Many, if not most, descriptions of the decline of Steller sea lions begin with the statement that the decline was first witnessed in the eastern Aleutian Islands in the mid 1970s and then spread westward to the central Aleutian Island and eastward to the western GOA in the late 1970s and early 1980s. Similarly, counts are frequently presented for the area from Kenai to Kiska Island, which is considered to enclose the center of abundance for the species. Genetic studies (Bickham *et al*. 1996, Loughlin 1997) provided the basis for distinguishing western and eastern management stocks of the sea lion, and additional work may allow further differentiation of stocks. The relation between diet diversity and population trend was studied using rookery groups identified by geographic location and rates of change. The rookery groups were those identified by York *et al*. (1996). These examples indicate that, depending on the purpose at hand, the total sea lion population may be split meaningfully into subpopulations in any number of ways.

However, if the purpose is to study or understand the natural (i.e., without human influence) population structure of the Steller sea lion, then the biogeography of the species must be defined more narrowly. Genetic studies may provide the best description of the result of biogeographic patterns, as they are likely the least influenced by human interaction. Demographic trends and foraging patterns may be influenced by human activities and, clearly, the artificial boundaries determined for political purposes should not have an influence on the natural biogeography of sea lions.

Those natural factors that determine their biogeography include climate and oceanography, avoidance of predators, distribution of prey, the reproductive strategy of the species, and movement patterns between sites. The marine habitat of the Steller sea lion tends to reduce variation in important environmental or climatic features, allowing the sea lion to disperse widely around the rim of the North Pacific Ocean. The decline of Steller sea lions off California may indicate a contraction in their range, depending on the explanation for that decline. Avoidance of terrestrial predators must clearly be an important factor, as rookeries and haulouts are virtually all located at sites inaccessible to such predators. Distribution of prey is likely a critical determinant of sea lion biogeography, and probably determines the extent of their dispersion during the non-reproductive season. The reproductive strategy of the species, on the other hand, requires aggregation at rookery sites, and therefore likely places important limits on the species' movement patterns and dispersion. Finally, movement patterns between sites determine, in part, the extent to which such groups of sea lions at different rookeries and haulout sites are demographically independent. Steller sea lions are generally not described as migrators. Adult males, for example, are described as dispersing widely during the non-reproductive seasons, and juveniles are described as dispersing widely after weaning and not returning to the reproductive site until they are approaching reproductive age (Calkins and Pitcher 1982).

Without a better understanding of movement patterns of sea lions, the geographic extent of potential fisheries effects can not be estimated with confidence. An understanding of the natural biogeography of the Steller sea lion is essential to describe their population size or status, trends, variability, and stability, and to identify the potential effects of human activities.

Population status and trends

Assessments of the status and trends of Steller sea lion populations are based largely on (a) counts of nonpups (juveniles and adults) on rookeries and haulouts, and (b) counts of pups on rookeries in late June and early July. Both kinds of counts are indices of abundance, as they do not necessarily include every site where animals haul out, and they do not include animals that are in the water at the time of the counts. Population size can be estimated by standardizing the indices (e.g., with respect to date, sites counted, and counting method), by making certain assumptions regarding the ratio of animals present versus absent from a given site at the time of the count, and by correcting for the portion of sites counted. Population estimates from the 1950s and 1960s (e.g., Kenyon and Rice 1961; see also Trites and Larkin 1992, 1996) are used with caution because counting methods and dates were not standardized, and the results contain inconsistencies that indicate the possibility of considerable measurement error at some sites in some years. Efforts to standardize methods began in the 1970s (Braham *et al*. 1980); as a result, counts conducted since the late 1970s are the most reliable index of population status and trends.

For the western U.S. population (i.e., west of 144°W long.), counts of adults and juveniles fell from 109,880 animals in the late 1970s to 22,167 animals in 1996, a decline of 80% (Fig. 16; Hill and DeMaster 1998, based on NMFS 1995, Strick *et al*. 1997, Strick *et al*. *in press*). From the late 1970s to 1996, abundance estimates for the GOA dropped from 65,296 to 9,782 (85%), and for the BSAI region dropped from 44,584 to 12,385 (72%). Counts in Russian territories (to the west of the action area for the BSAI and GOA groundfish fisheries) have also declined and are currently estimated to be about one-third of historic levels (NMFS 1992). Counts in southeast Alaska (to the east of the action area for the GOA groundfish fisheries) are increasing slowly.

For the western population, the number of animals lost appears to have been far greater from the late 1970s to the early 1990s. Nevertheless, the rate of decline in the 1990s has remained relatively high: the 1996 count was 27% lower than the count in 1990. Counts conducted in 1998 suggest that the overall decline continues (Table 6; data from T. Loughlin, pers. comm. and from Sease and Loughlin 1999, their Tables 4 and 5). The counts reported in Table 6 are for rookery and haulout “trend sites” (top) and for rookery trend sites only (bottom). Counts at rookery trend sites declined from 1996 to 1998 in all major regions except the eastern GOA (Sease and Loughlin 1999, their Table 5). In addition, the portion of (nonpup) sea lions counted on rookeries versus haulouts appears to have declined considerably during the 1990s (Sease and Loughlin 1999, their Table 7). This drop could occur for a number of reasons: a decrease in reproductive rate for females, a decrease in number of males on the rookeries, a shift in the age distribution from relatively more mature animals to relatively fewer mature animals (such as might occur with greater juvenile survival), or a shift in the timing of reproduction relative to the timing of the counts. To the extent that this shift indicates a decrease in reproductive rate, then this trend bodes poorly for near future recovery.

Although the decline of the western population has occurred over extensive areas, site-by-site evaluation of the counts may be helpful for understanding the decline and anticipating the nature of threats to the species as local populations dwindle to extremely low numbers. However, changes observed at specific sites must be interpreted with caution because factors affecting counts at specific sites are generally unknown or poorly known. Perhaps more importantly, animals move between sites on temporary, seasonal, and permanent bases. Therefore, the extent to which the collection of animals at a given site represent an independent or meaningful population unit is not yet clear.

For the eastern population (east of 144°W long.), counts of nonpups (adults and juveniles) have increased overall from just under 15,000 in 1982 to just over 20,000 in 1994 (Hill and DeMaster 1998). Counts of nonpups in California/Oregon were essentially unchanged from 1982 to 1996 at about 3,300. In California alone, the counts during this period represent a decline of over 50% since the first half of this century (NMFS 1995). Counts of nonpups in British Columbia increased from 4,700 to 8,100 in 1994. The increase in British Columbia likely represents partial recovery from the effects of control programs in the earlier part of the century. In 1913, 10,000-12,000 animals (including pups) were counted; in 1965, 4,000 were counted (Bigg, 1988). In southeast Alaska, counts of non-pups at trend sites have increased from 6,400 in 1979 to 8,700 in 1998 (NMFS 1995, Sease and Loughlin 1999). The number of pups born in southeast Alaska increased from ca. 2,200 in 1979 to ca. 3,700 in 1994 (NMFS 1995). Pup production increased at Hazy and Forrester Islands. Forrester Island has become the largest rookery for the entire species, with just under 3,300 pups born there in 1991 (NMFS 1995).

Population projections

Based on recent trends in southeast Alaska and British Columbia, prospects for recovery of the eastern population are encouraging. Population viability analyses have been conducted for the western population by Merrick and York (1994) and York *et al.* (1996). While such analyses require some assumptions, they provide a context for management and an indication of the severity and urgency of the sea lion dilemma.

The results of these analyses indicate that the next 20 years may be crucial for the western population of Steller sea lions, if the rates of decline observed in recent years continue. Within this time frame, it is possible that the number of adult females in the Kenai-to-Kiska region could drop to less than 5000. Extinction rates for rookeries or clusters of rookeries could increase sharply in 40 to 50 years, and extinction for the entire Kenai-to-Kiska region could occur in the next 100-120 years.

These projections are reasonable, given the severity of the overall decline (80% in about two decades) and the declines observed for specific time periods and regions. From 1985 to 1989, counts at trend sites in the central and western GOA declined by 55% and 39%, respectively. In the same time period, counts at trend sites in the eastern and central Aleutian Islands declined by 60% and 67%, respectively (data for 1985 are not available for the western Aleutian Islands). From 1989 to 1996, counts at trend sites in the eastern and central GOA dropped by 70%, and 61% respectively. These counts represent severe drops that argue that the above population projections are clearly feasible.

Listing Status

On 26 November 1990, the Steller sea lion was listed as threatened under the Endangered Species Act of 1973 (55 FR 49204). The listing followed a decline in the U.S. population of about 64% over the three decades prior to the listing. In 1997, the species was split into two separate stocks on the basis of demographic and genetic dissimilarities (Bickham *et al*. 1996, Loughlin 1997), the status of the western stock was changed to endangered, and the status of the eastern stock was left unchanged (62 FR 30772).

3.9 Critical habitat description

The term "critical habitat" is defined in the Endangered Species Act (16 U.S.C. 153) to mean:

> *(i) the specific areas within the geographic area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management consideration or protection; and (ii) the specific areas outside of the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential to the conservation of the species.*

The ESA also states that "Except in those circumstances determined by the Secretary, critical habitat shall not include the entire geographical area which can be occupied by the threatened or endangered species."

By this definition, critical habitat includes those areas that are essential to the "conservation" of a threatened or endangered species. The ESA defines the term "conservation" as: ". . . to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary." That is, the status of the species would be such that it would be considered "recovered." Therefore, the area designated as critical habitat should contain the physical and biological resources necessary to support and sustain a population of a threatened or endangered species that is sufficiently large and persistent to be considered recovered.

Establishment of Critical Habitat

The areas designated as critical habitat for the Steller sea lion were determined on the basis of the available information on life history patterns of the species, with particular attention paid to land sites where animals haul out to rest, pup, nurse their pups, mate, and molt, and to marine sites considered to be essential foraging areas. The foraging areas were determined on the basis of sightings of sea lions at sea, incidental catch data (Loughlin and Nelson 1986, Perez and Loughlin 1991), and foraging studies using satellite-linked tracking systems. Critical habitat areas were determined with input from NMFS scientists and managers, the Steller Sea Lion Recovery Team, independent marine mammal scientists invited to participate in the discussion, and the public. The proposed rule for establishment of critical habitat for the Steller sea lion was published on 1 April 1993 (58 FR 17181), and the final rule was published on 27 August 1993 (58 FR 45269). The following areas have been designated as critical habitat in the action area of one or more of the proposed fisheries (Map 1).

(a) Alaska rookeries, haulouts, and associated areas. In Alaska, all major Steller sea lion rookeries identified in Table 1 [their Table 1] and major haulouts identified in Table 2 [their Table 2] and associated terrestrial, air, and aquatic zones. Critical habitat includes a terrestrial zone that extends 3,000 feet (0.9 km) landward from the baseline or base point of each major rookery and major haulout in Alaska. Critical habitat includes an air zone that extends 3000 feet (0.9 km) above the terrestrial zone of each major rookery and major haulout in Alaska, measured vertically from sea level. Critical habitat includes an aquatic zone that extends 3,000 feet (0.9 km) seaward in State and Federally managed waters from the baseline or basepoint of each major haulout in Alaska that is east of 144˚ W long. Critical habitat includes an aquatic zone that extends 20 nm (37 km) seaward in State and Federally managed waters from the baseline or basepoint of each major rookery and major haulout in Alaska that is west of 144˚ W long.

Three special aquatic foraging areas in Alaska. Three special aquatic foraging areas in Alaska, including the Shelikof Strait area, the Bogoslof area, and the Seguam Pass area.

(1) Critical habitat includes the Shelikof Strait area in the GOA which . . . consists of the area between the Alaska Peninsula and Tugidak, Sitkinak, Aiaktilik, Kodiak, Raspberry, Afognak and Shuyak Islands (connected by the shortest lines): bounded on the west by a line connecting Cape Kumlik (56˚38″/157˚26′W) and the southwestern tip of Tugidak Island (56˚24′/154˚41′W) and bounded in the east by a line connecting Cape Douglas (58˚51′N/153˚15′W)and the northernmost tip of Shuyak Island (58˚37′N/152˚22′W).

(2) Critical habitat includes the Bogoslof area in the Bering Sea shelf which . . . consists of the area between 170˚00′W and 164˚00′W, south of straight lines connecting 55˚00′N/170 00′W and 55˚00′N/168˚00′W; 55˚30′N/168˚00′W and 55˚30′N/166˚00′W; 56˚00′N/166˚00′W and 56˚00′N/164˚00′W and north of the Aleutian Islands and straight lines between the islands connecting the following coordinates in the order listed:

52˚49.2′N/169˚40.4′W; 52˚49.8′N/169˚06.3′W; 53˚23.8′N/167˚50.1′W; 53˚18.7′N/167˚51.4′W; 53˚59.0′N/166˚17.2′W; 54˚02.9′N/163˚03.0′W; 54˚07.7′N/165˚40.6′W; 54˚08.9′N/165˚38.8′W; 54˚11.9′N/165˚23.3′W; 54˚23.9′N/164˚44.0′W

(3) Critical habitat includes the Seguam Pass area which . . . consists of the area between 52˚00′N and 53˚00′N and between 173˚30′W and 172˚30′W.

Physical and biological features of Steller sea lion critical habitat

For the Steller sea lion, the physical and biological features of its habitat that are essential to the species' conservation are those that support reproduction, foraging, rest, and refuge. Land or terrestrial habitat is relatively easy to identify on the basis of use patterns and because land use patterns are more easily observed. The areas used are likely chosen because they offer refuge from terrestrial predators (e.g., are inaccessible to bears), include suitable substrate for reproductive activities (pupping, nursing, mating), provide some measure of protection from the elements (e.g., wind and waves), and are in close proximity to prey resources.

Prey resources are the most important feature of marine critical habitat. Marine areas may be used for a variety of other reasons (e.g., social interaction, rafting or resting), but foraging is the most important sea lion activity that occurs when the animals are at sea. Two kinds of marine habitat were designated as critical. First, areas around rookeries and haulouts were chosen based on evidence that many foraging trips by lactating adult females in summer may be relatively short (20 km or less; Merrick and Loughlin 1997). Also, mean distances for young-of-the-year in winter may be relatively short (about 30 km; Merrick and Loughlin 1997). These young animals are just learning to feed on their own, and the availability of prey in the vicinity of rookeries and haulouts must be crucial to their transition to independent feeding after weaning. Similarly, areas around rookeries are likely to be important for juveniles. While the foraging patterns of juveniles have not been studied in the BSAI region, it is possible that they depend considerably on resources close to haulouts. Evidence indicates that decreased juvenile survival may be an important proximate cause of the sea lion decline (York 1994, Chumbley *et al*. 1997), and that the growth rate of individual young seals was depressed in the 1980s. These findings are consistent with the hypothesis that young animals are nutritionally stressed. Furthermore, young animals are almost certainly less efficient foragers and probably have relatively greater food requirements which, again, suggests that they may be more easily limited or affected by reduced prey resources or greater energetic requirements associated with foraging at distant locations. Therefore, the areas around rookeries and haulouts must contain essential prey resources for at least lactating adult females, young-of-the-year, and juveniles, and those areas were deemed essential to protect.

Second, three areas were chosen based on 1) at-sea observations indicating that sea lions commonly used these areas for foraging, 2) records of animals killed incidentally in fisheries in the 1980s, 3) knowledge of sea lion prey and their life histories and distributions, and 4) foraging studies. In 1980, Shelikof Strait was identified as a site of extensive spawning aggregations of pollock in winter months. Records of incidental take of sea lions in the pollock fishery in this region provide evidence that Shelikof Strait is an important foraging site (Loughlin and Nelson 1986, Perez and Loughlin 1991). The southeastern Bering Sea north of the Aleutian Islands from Unimak Island past Bogoslof Island to the Islands of Four Mountains is also considered a site that has historically supported a large aggregation of spawning pollock, and is also an area where sighting information and incidental take records support the notion that this is an important foraging area for sea lions (Fiscus and Baines 1966, Kajimura and Loughlin 1988). Finally, large aggregations of Atka mackerel are found in the area around Seguam Pass. These aggregations have supported a fishery since the 1970s, and are in close proximity to a major sea lion rookery on Seguam Island and a smaller rookery on Agligadak Island. Atka mackerel are an important prey of sea lions in the central and western Aleutian Islands. Records of incidental take in fisheries also indicate that the Seguam area is an important for sea lion foraging (Perez and Loughlin 1991).

While many of the important physical and biological elements of Steller sea lion critical habitat can be identified, most of those features (particularly biological features) cannot be described in a complete and quantitative manner. For example, prey species within critical habitat can not be described in detail or with a demonstrated measure of confidence, and the lack of such information is an important impediment to the analysis of fishery effects. Walleye pollock, Atka mackerel, Pacific cod, rockfish, herring, capelin, sand lance, other forage fish, squid, and octopus are important prey items found in Steller sea lion critical habitat but for most (if not all) of these species, we are not able to reliably describe their abundance, biomass, age structure, or temporal and geographic distribution within critical habitat with sufficient clarity and certainty to understand how they interact with Steller sea lions or other consumers, including fisheries.

4.0 Environmental Baseline

Large whales

Status of the species within the action areas

Relatively little information is available on the status of the six large protected cetaceans considered in this opinion. Recent sightings suggest a small number of northern right whales are beginning to use the southeastern Bering Sea where many of the subject fisheries occur. The stock structure of the northern right whale in the action areas is unknown. Abundance is also unknown, but the species is clearly in a state of severe depletion. As virtually nothing is known of the abundance of these animals, their trends in the action area are also unknown.

NMFS estimates that the population of Bering Sea stock of bowhead whales is 8,200 animals and computed the annual rate of increase of 3.1%. Bowhead whales may be present in the northern part of the action area in the winter.

The overall abundance of the blue whale is also unknown in the North Pacific, but abundance of blue whales in the eastern North Pacific has been estimated at 3500. Current information suggests that two blue whale stocks may occur in the action areas, but abundance and trends for those two stocks are unknown.

Only one stock of fin whale is recognized for the North Pacific. This stock occurs in the action area, but its abundance and trends are unknown.

The sei whale may be present only in the more southern portions of the action area, south of the Aleutian Islands. Abundance and trends are unknown.

Relatively more information is available for humpback whales in the North Pacific. Two stocks occur in the action areas, a western North Pacific stock and a central North Pacific stock. Abundance and trends of the western stock are unknown. The central stock was estimated at 4,005 for 1991 to 1993. Trends for the central stock are not well described, although some data suggest that it may be increasing.

Sperm whales occur in the action areas, but are generally limited to areas of greater depth (e.g., 200 m or deeper). Their abundance and trends are unknown.

Known or suspected factors contributing to the current status of the large cetaceans in the action areas

The dominant factor determining the status of the large protected cetaceans in the North Pacific is the historical commercial killing of these animals in the latter half of the last century and through the early and middle part of this century. Ship strikes, subsistence harvests, entanglement in fishing gear or gear related to other oceanic activities by humans have contributed to their declines, but probably to a trivial or negligible degree, particularly compared to the effects of commercial whaling. Other possible causes include disease, natural environmental changes, effects of contaminants, and disturbance.

Steller sea lions

Status of the species within the action areas

Total abundance for the western population of Steller sea lions in 1996 has been estimated as 39,500 animals (Hill and DeMaster 1998; based on 1996 counts [NMFS unpubl. data] and correction factors derived by Loughlin *et al*. [1992]). Based on these counts (as an index of population abundance), the western population declined by 80% since the late 1970s.

The 1996 counts used to derive this estimate included 11,710 animals (nonpups) in the BSAI region and 9,782 animals (nonpups) in the GOA. These counts suggest that, in 1996, about 54% of the western population was in the BSAI region and 46% in the GOA. Counts in 1998 indicate that the number of sea lions in both the BSAI and GOA regions continue to decline (Sease and Loughlin 1999). These estimates should be used cautiously when assessing the potential effects of a fishery. Due to mobility of both the fish stocks and sea lions, the effects of a fishery may extend beyond the distribution of fishing effort. Critical habitat for the western population (west of 144°W long.) has been designated around 40 rookeries and 82 haulouts (approximate, overlapping circles with a radius of 20 nm; Fig. 17) and special foraging areas at Seguam Pass, in the southeastern Bering Sea, and in Shelikof Strait.

Total abundance of the eastern population of Steller sea lions in 1996 has been estimated as ca. 30,400 (Hill and DeMaster 1998). This number is a minimum estimate not corrected for animals at sea during the counts. Based on counts in 1994 (20,176) and 1982 (14,895), the eastern population increased by 35% during that period (suggesting an annual growth rate of about 2.5%).

The total abundance estimate of ca. 30,400 for the eastern population was derived by summing counts of animals from southeast Alaska (14,571), California, Oregon and Washington (6,555), and British Columbia (9,277), and includes both nonpups (adults and juveniles) and pups. These counts suggest that, in 1996, about 48% of the eastern population was in southeast Alaska, 22% in California, Oregon, and Washington, and 31% in British Columbia (with rounding error). Counts in southeast Alaska during 1998 indicate a continued increase in that area (Sease and Loughlin 1999). Critical habitat for the eastern population (east of 144°W long.) has been designated around 3 rookeries and 22 haulouts in the eastern GOA or southeast Alaska and 6 rookeries in California or Oregon. For the eastern population, critical habitat extends 0.9 km seaward from these rookeries and haulouts. No special foraging areas have been included in critical habitat for the eastern population.

The potential effects of the groundfish fisheries on both the western and eastern populations include either operational effects (incidental kill, gear conflict, entanglement, destruction of catch) or biological effects (competition for prey, changes to the community composition, changes in the age/size structure of prey populations). Operational effects could result in injury or death of sea lions. Biological effects could result in decreases in condition, growth, reproduction, or survival.

Known or suspected factors contributing to the current status of Steller sea lions or their critical habitat

The decline of the western population of Steller sea lions is not the result of a single factor, and to search for *the single cause* is a misleading oversimplification. Multiple factors have contributed to the decline, and multiple factors may still be preventing recovery. The identification of one such factor does not rule out the possibility that others are also acting, perhaps synergistically, to prolong the decline. Furthermore, the causes for the decline appear to include both natural and anthropogenic influences.

- Intentional take of sea lions has occurred coincident with fisheries. From the 1950s (and probably before) to the 1970s, such take was not only condoned, but in many cases encouraged or rewarded. The rate or magnitude of intentional take has been estimated (Alverson 1992), although reporting and documentation have not been sufficient to provide reliable estimates of total take. Intentional take has likely subsided considerably since the passage of the MMPA and other protective legislation, although anecdotal reports indicate that some level of intentional take may still continue.

- Incidental take in trawl fisheries included thousands or tens of thousands of animals (Loughlin and Nelson 1986, Perez and Loughlin 1991) through the 1980s, and contributed to the decline of the population in the 1970s and 1980s. Currently, however, incidental take has been reduced to negligible levels.

- Commercial harvest of adult males in 1959 likely had no significant effect on population trends. However, harvest of over 45,000 pups in 1963 to 1972 contributed to local population trends in the 1960s through the early 1980s in the GOA and the eastern Aleutian Islands. Similarly, subsistence harvests prior to the 1990s were not measured but may have contributed to population decline in localized areas where such harvests were concentrated.

- Pollutants and marine debris (entanglement) may have contributed to the decline by altering growth, reproduction, or survival of sea lions. The evidence available to date does not support the contention that these factors have played a significant role.

- Harassment has likely occurred in many areas and may have been very disruptive to sea lion colonies on rookeries or haulouts, thereby leading to redistribution or deaths of animals. Such harassment could have contributed to mortality if animals were shot, females were separated from their pups for long periods, or animals (especially pups) were trampled or crushed or otherwise injured in the stampedes that often accompany such harassment. Nevertheless, harassment is thought to be less common at present, and the data are not sufficient to demonstrate that harassment was a significant contributor to the decline. Harassment is also a less likely explanation in the remote areas of the sea lion range where declines have, nonetheless, been observed (e.g., central and western Aleutian Islands).

- Disease has the potential to cause a major decline but, to date, the available information does not support the contention that disease was a significant factor.

- Killer whales and sharks take Steller sea lions, but such predation is not thought to have caused the decline. The significance of predation may have increased with the decline of sea lions. That is, if the number of sea lions taken has remained relatively constant, then the rate of mortality due to predation would increase because the abundance of sea lions has declined so significantly. However, the number of sea lions taken by killer whales and sharks is not known, and it is also possible that the number of sea lions taken has decreased in proportion to the decline of sea lions.

- Major changes have occurred in the BSAI and GOA ecosystems. Variation in physical and biological factors, in combination, likely contributed to the observed shift in trophic structure, and the dominance of pollock and flatfish in these systems.

- At the same time, the BSAI and GOA ecosystems have experienced the development and expansion of major fisheries for essential sea lion prey. The fisheries have also contributed to changes in the trophic structure of these ecosystems, but as is the case with natural changes, the extent of fisheries-related effects on the ecosystems, at large, can not be determined. To date, neither our science nor our management regimes are structured to distinguish natural from fisheries related effects on these ecosystems. With respect to Steller sea lions, however, fisheries target important prey resources at times and in areas where sea lions forage.

In the face of all these changes and influencing factors, the western population of Steller sea lions has not been able to maintain itself. The available evidence suggests that a significant part of the problem is lack of available prey. Studies of animals collected in the GOA in 1975-1978 and 1985-1986 indicate that animals in the latter collection were smaller, took longer to reach reproductive maturity, produced fewer offspring, tended to be older, and exhibited signs of anemia --- all observations consistent with the hypothesis of nutritional stress (Calkins and Goodwin 1988, Pitcher *et al*. *in review*, York 1994). In addition, survival of juvenile animals appeared to have dropped in both the eastern Aleutian Islands (Ugamak Island; Merrick *et al*. 1987) and the GOA (Marmot Island; Chumbley *et al*. 1997). These results, the evidence of substantial changes in the physical and biological features of the BSAI and GOA ecosystems, and the expansion of fisheries in these regions all support the contention that lack of available prey has contributed significantly to the past decline of the western population, and may still be so contributing.

Trends of the eastern population likely reflect a change in human activities that contributed to their decline in the earlier part of this century. Since at least 1912, or earlier, sea lions were killed as pests and to reduce their supposed effect on commercial fish stocks. Growth and recovery in the latter part of this century may be due to reductions in both killing and disturbance in the waters of southeast Alaska and British Columbia. The relatively slow recovery (2-3% annually from 1982 to 1994) suggests that some factors may be acting to slow recovery, but recovery is still occurring for the eastern population.

5.0 Effects of the Actions

This biological assessment analyzes the effects of actions under the Federal crab FMP on seven endangered whale species, the threatened eastern population of Steller sea lions, the endangered western population of Steller sea lions, and the critical habitat designated for Steller sea lions. The crab FMP defers management of the BSAI crab fisheries to the State of Alaska. State crab management is constrained by the framework established in the FMP and the Magnuson-Stevens Act and other applicable Federal law. Based on this effects analysis and an analysis of cumulative effects, NMFS separately determines whether the actions under the FMP are likely to adversely effect the continued existence of a protected species or destroy or adversely modify designated critical habitat.

Critical habitat has been designated for the Steller sea lion, and includes areas used by animals from both the eastern and western populations. As will become evident in the following discussion, the key questions in evaluating the effects of the actions under the crab FMP on populations of protected marine mammals are whether the fisheries conducted under these actions compete with protected marine mammals, and whether the fishing methods and gear deployed harm or kill protected marine mammals. Due to the fact that some of the crab fisheries operate in Steller sea lion critical habitat, an analysis of these actions on Steller sea lion critical habitat is necessary. In the action areas, critical habitat has not been designated for any of the large protected whales

Fisheries interact with marine mammals either operationally or biologically (Lowry *et al*. 1982). Operational interactions between marine mammals and fishing gear (whether it is actively fishing or derelict; e.g., ghostfishing or entanglement in debris) occur when marine mammals remove or destroy catch from fishing gear or when marine mammals are injured or killed by fishing gear. Operational interactions may directly affect marine mammals populations, but are not likely to directly affect their habitat. The operational effects of the proposed fisheries can be assessed because fishery observer programs have generated substantial information on operational interactions between marine mammals and fisheries. Biological interactions result from disturbance of normal marine mammal foraging behavior, competition with marine mammals for prey, changes in prey size/age structure, and changes in the composition of the marine community. This Biological Assessment assesses the effects of both forms of interaction between protected species and the crab fisheries as implemented under the crab FMP.

For clarity, this analysis is organized around the two categories (operational and biological); the analysis will first address the operational effects of the actions on the large protected whales and Steller sea lions, and then on the Steller sea lion critical habitat. The final section will address the biological effects of the actions on the large protected whales and Steller sea lions.

5.1 Operational effects - Marine Mammals

For all seven species of large whales considered here (northern right whale, bowhead whale, blue whale, fin whale, sei whale, humpback whale, and sperm whale), and Steller sea lions, plausible operational effects include ship strikes and gear entanglement. NMFS does not expect these patterns of entanglements or ship to change in the foreseeable future and, therefore, does not expect the proposed action to have adverse, operational effects on large whales or Steller sea lions.

Information is lacking that indicates significant direct interactions between the BSAI crab fisheries and the endangered and threatened species of marine mammals in the BSAI. Direct interactions are interactions between marine mammals and fishing vessels and pot gear, including buoy lines. Information on direct interactions comes from observer data, anecdotal accounts, and NMFS Protected Resources Division. From all of this information, no marine mammals have been reported to incur injury or mortality in the BSAI crustacean pot fisheries managed under the FMP. One exception was a humpback whale entanglement which is discussed below. Limited direct interactions between the fishery and marine mammals is most likely due to the nature of pot gear, the time of the crab fisheries (in the fall and winter), and the location of the fisheries (far from shore). Similarly, ship strikes have not been reported for vessels in the BSAI fisheries.

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

NMFS has looked into interactions between finfish pot fisheries and humpback whales (64 FR 9067). No humpback whale mortalities were observed during the 1990-97 Bering Sea and Gulf of Alaska finfish pot fisheries monitored by NMFS observers. During 1997, there were three reports of humpback whales entangled in lines with attached buoy in Southeast Alaska (not part of the action area), but these were deemed likely to be observations of the same whale based on the limited information in the reports. Based on the limited information, it was not possible to attribute these interactions to a particular fishery.

Direct interactions between marine mammals and crab fishing vessels are reported by observers. Observers are instructed to take pictures of marine mammals and to report any interactions to NMFS Protected Resources Division. One observer on a golden king crab fishing vessel reported interactions with a humpback whale in Federal waters near the Island of Four Mountains. The State requires 100% observer coverage for the golden king crab fishery. On September 3, 1997, in the longline pot fishery for golden (brown) king crab in the Aleutian Islands, a humpback whale's fluke was entangled in the groundline. The crew cut the line to free the whale and the observer documented the incident with photos and reported it to NMFS. The whale was released and not known to be injured or killed.

The golden king crab fishery is more susceptible to direct interactions because it occurs in August-September and in waters nearer to shore, although this was the only reported interaction. Under usual circumstance of gear deployment and retrieval, the groundlines are taunt with the weight of the pots, so entanglement is not probable. Golden king crab fishing activity occurs year round in portions of the registration area. Since the fall of 1995 through April, 2000 there have been over 11,600 observer-days of vessel coverage. During that same period over 975,000 king crab pots have been retrieved. The crab pots in this fishery are not fished individually but by longline with a minimum (in regulation) of 10 king crab pots attached. How the whale came in contact and then became entangled with the line can only hypothesized. The indications were that this probably occurred while the gear was being retrieved. During the retrieval of the gear there would be several pots suspended from the longline as it is retrieved in the water column (mean depth fished 1998/99 = 185 fathoms). The pots each weigh from 300 to 700 pounds depending on their dimensions. It is difficult to envision any slack in the longline with the weight of all the suspended pots hanging from it (L. Boyle, ADF&G Dutch Harbor, personal communication).

The fact that there have been no other reported interactions of any type between marine mammals and crab vessels in this fishery would further indicate how improbable this entanglement actually was. NMFS assumes that this was a single occurrence and, based on the history of information and the outcome of the event, the interaction had insignificant effects on the humpback whale population. Any future interaction between the fishery and humpback whales will be documented and reported.

NMFS does not expect the fishing patterns to change in the foreseeable future and, therefore, does not expect the proposed action to have adverse, operational effects of large whales or Steller sea lions.

5.2 Operational effects - Critical Habitat

The all of the crab fisheries authorized under the crab FMP that occur, to some extent, in Steller sea lion critical habitat include. Maps 2 though 8 show the amount of harvest over the last 10 years that occurs in critical habitat. Plausible operational effects of these crab fisheries on critical habitat include gear placement and removal on the benthic habitat.

The crab fisheries use pot gear. This gear type likely affects habitat during setting and retrieval of pots; however, no research quantifying the impacts has been conducted to date. Whatever the direct effects of setting and pulling pot gear on the benthic environment, they appear to be small in comparison to the potentially large-scale effects of "ghost-fishing" by derelict pots. Lost by the fishery, these pots may continue to entrap crab and fish until their netting or escape panels disintegrate (Stevens et al. 2000). Inasmuch as they are unbated, the primary attraction of derelict pots is their physical structure, which adds complexity and vertical relief to a generally featureless environment. Section 3.1.2.3 of the groundfish FSEIS (NMFS 1998) provides a detailed description of the impacts of pot gear on the sea floor. No evidence indicates the deployment or retrieval of pot irreparably alters the benthic environment.

Like other fisheries, pot fisheries incur some bycatch of incidental fish and crab. Bycatch in crab pot fisheries includes crabs, octopus, Pacific cod, halibut, and other flatfish (Tracy 1994). However, the vast majority of bycatch in the crab fisheries is females of target species, sublegal males of target species, and non-target crabs. The State has implemented bycatch reduction measures to reduce the amount of crab bycatch in the directed crab fisheries. Since pot gear selectively harvests primarily legal sized crab, the crab fisheries do not remove significant amounts of other species from the ecosystem.

NMFS does not expect the fisheries impacts on habitat to change in the foreseeable future and, therefore, does not expect the crab fisheries to have adversely modify Steller sea lion critical habitat.

5.3 Biological effects

The existing information suggests that the BSAI crab fisheries do not have a significant effect on the populations of any of the protected species of marine mammals. Information on biological effect comes from directed research, such as stomach analysis of marine mammals and study of the trophic interactions of crab.

As shown below, crab are not a prey item of these marine mammals, and, as discussed above, the crab fisheries do not remove significant amounts of any other species as bycatch from the ecosystem. Therefore, the removal of crab is not likely to alter the prey availability for protected marine mammals.

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

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

In review of the Biological Opinion on Groundfish Fisheries in the BSAI and Gulf of Alaska (BO) (NMFS 1999), which provides a partial listing of studies on the prey of Steller sea lions, crab are not a significant prey species. In fact, of the 20 studies summarized in the BO, only five studies list crab in the stomach contents, and, in each of these cases, crab were found in small amounts. An indirect linkage may exist from the fact that Steller Sea lions consume species that consume crab. However, the fishery may not significantly impact this linkage because most crab consumers eat larval crab, small crab, and molting females, none of which the fishery targets. The crab fisheries may have contributed to changes in the composition or structure of these ecosystems, but the nature of such hypothetical effects is not clear, if they occur.

Finally, these fisheries may increase the level of disturbance to marine mammals simply as a function of the number of vessels and the amount of gear present in areas that marine mammals might otherwise use. Potential exists for disturbance of Steller Sea lions by the Aleutian Islands golden king crab fishery because a portion of the fishery occurs in the critical habitat around rookeries, haulouts, and associated areas (see Map 8). Here, too, this effect is at least hypothetically feasible, but cannot be meaningfully measured, detected, or evaluated with the information available.

NMFS does not expect these fishing patterns to change in the foreseeable future and, therefore, does not expect the proposed action to have adverse, biological effects on large whales or Steller sea lions.[2]

Some basic knowledge exists on the trophic interactions of the major crab species. These are summarized below.

Pacific cod is the main predator on Tanner crabs in terms of biomass. Predators consume primarily age 0 and 1 juvenile Tanner crab less than 7 cm carapace width. Flathead sole, rock sole, and yellowfin sole are important predators in terms of numbers of small crab. Larval predators include salmon, herring, and jellyfish. There is a high rate of cannibalism among juvenile crabs. Annual consumption of Tanner crabs by groundfish ranged from 10 billion to 153 billion crabs, consisting primarily of Age 0 and Age 1 crabs (Livingston et al. 1994). Yellowfin sole and flathead sole were found to be the primary consumers of small Tanner crabs, whereas Pacific cod preyed on the larger juveniles.

Snow crab feed on an extensive variety of benthic organisms including bivalves, brittle stars, crustaceans (including other snow crab), polychaetes and other worms, gastropods, and fish. In turn, they are consumed by a wide variety of predators including bearded seals, Pacific cod, halibut and other flat fish, eel pouts, sculpins, and skates. Predators consume primarily age 0 and 1 juvenile snow crab less than 7 cm carapace width. Flathead sole, rock sole, and yellowfin sole are important predators in terms of numbers of small crab. Larval predators include salmon, herring, and jellyfish. There is a high rate of cannibalism among juvenile crabs.

Predation of crabs by groundfish removes large numbers of young snow crab. For snow crabs, estimates of annual consumption by groundfish from May through September ranged from 9 billion to 31 billion crabs (Livingston et al. 1993). Snow crabs consumed were primarily age 1, and to a lesser extent age 2 and 3 crabs. Pacific cod is a primary predator of snow crab, particularly softshell female and juvenile crab (Livingston 1989). Flathead sole, yellowfin sole, and rock sole also prey on young snow crabs (Livingston et al. 1993).

A number of fish species are known to feed on larval red king crab, including Pollock, Pacific herring, sockeye salmon, and yellowfin sole. Once the crab settle on the sea floor, they are prey to a number of commercial and non-commercial fish species such as most flatfish species, halibut, sablefish, skates, sculpins, and other benthic invertebrates, such as sea stars. A high rate of cannibalism by juvenile red king crab on younger crab also exists. Studies have documented that Pacific cod consume soft-shelled female adult red king crab. Minimal research has been conducted on the trophic interactions of blue king crab. We can assume that blue king crab have similar trophic interactions as red king crab, however, blue king crab are predominantly distributed around the Pribilof Islands and St. Matthew Island.

Although yellowfin sole and Pacific cod are known predators of juvenile and molting red king crab (Livingston 1989), data suggest that mortality caused by groundfish predators on adult red king crab may be

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

low during summer months. It has been estimated that Pacific cod consumed about 1.4% to 3.8% of the female red king crab stock during the early 1980's, which suggested to Livingston (1989), that these rates were not the major factor behind the Bristol Bay red king crab stock crash. In the late 1980's, consumption by Pacific cod was estimated at 3.8% to 14.3 % of the female red king crab stock (Livingston et al. 1994). Although it has been hypothesized that juvenile sockeye salmon may impact recruitment of red king crab in Bristol Bay, subsequent analysis has failed to support this theory (Tyler and Kruse 1996).

Crab predators and competitors have been at relatively high levels through the 1980's and 1990's. Biomass of crab competitors (inshore benthic infauna consumers such as starfish and flatfish) increased about 40% from 1979-1993 (Livingston et al. 1994). Most of this increase is attributable to a growing rock sole biomass, and to a lesser extent starfish and flathead sole biomass. Of the crab species, only snow crab comprises a substantial portion of the infauna consumer guild (species that eat clams, polycheates, etc.). Yellowfin sole had dramatically increased in abundance in the early 1980's to become the largest component of this guild until the early 1990's when rock sole became co-dominant. Mean size at age has declined for yellowfin sole and rock sole, indicating stress caused by competition, and to a lesser extent a decrease in average bottom temperature (Livingston et al. 1994).

Popular opinion has been that predation by groundfish has been a major source of natural mortality for juvenile and molting crabs in the Bering Sea, particularly in years of high abundance of predators. Competition with groundfish may also lead to slower growth, as well as reduced resistance to disease and predation. A recent analysis concluded that changes in Bering Sea crab and groundfish populations were not related (Kruse and Zheng 1999). That is, it does not appear from statistical analysis that groundfish predation caused declines in crab populations. To better illustrate this for snow crabs, Kruse and Zheng (1999) noted that although snow crabs are heavily preyed upon by Pacific cod, strong year classes of snow crabs co-occurred with high cod biomass resulting in positive correlations.

6.0 Conclusions

After reviewing the current status of the northern right whale, the bowhead whale, the blue whale, the fin whale, the sei whale, the humpback whale, the sperm whale, the western and eastern populations of Steller sea lions, the critical habitat designated for Steller sea lions, the environmental baseline for the action area, the effects of the crab fisheries prosecuted under the FMP, NMFS Sustainable Fisheries concludes that the actions considered in this Biological Assessment, as proposed, are not likely to (1) result in the direct take or compete for the prey of the seven large protected whale species or the western and eastern population of Steller sea lions, or (2) destroy or adversely modify designated Steller sea lion critical habitat. We believe that the effects observed are insignificant or discountable, therefore, we believe formal consultation is not required.

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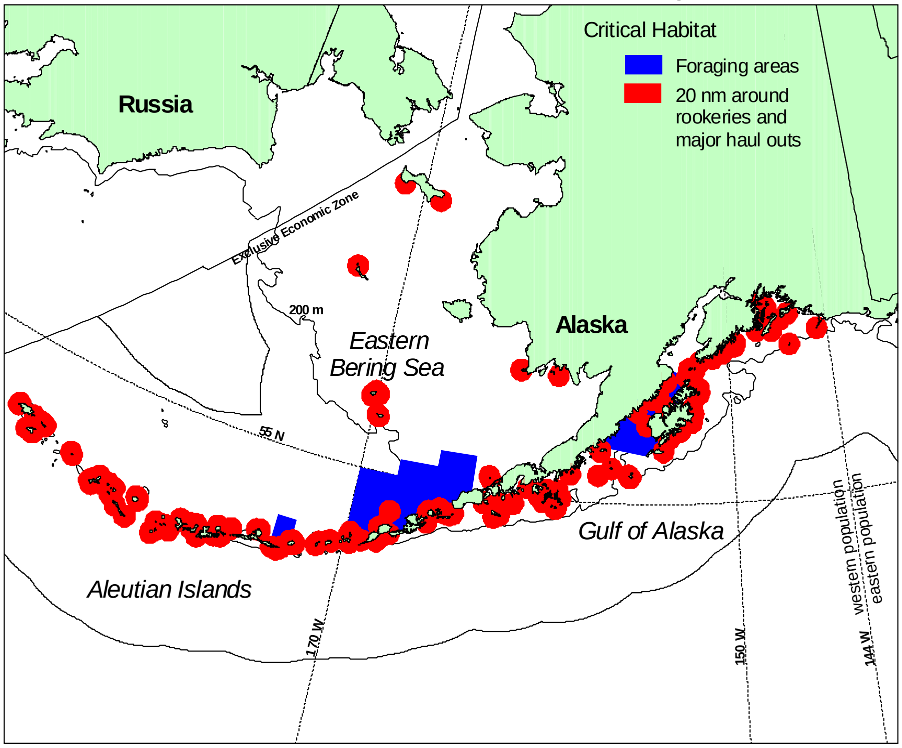
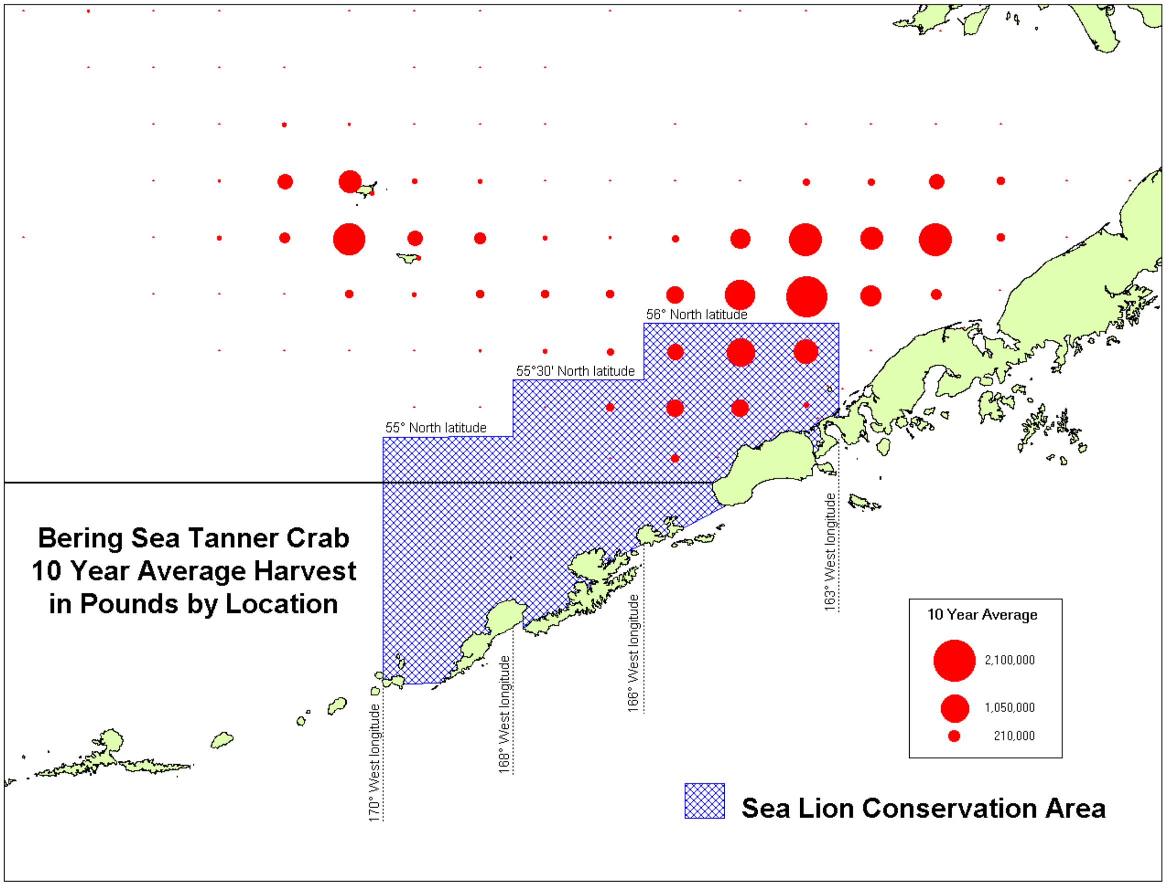
8.0 Maps and Figures

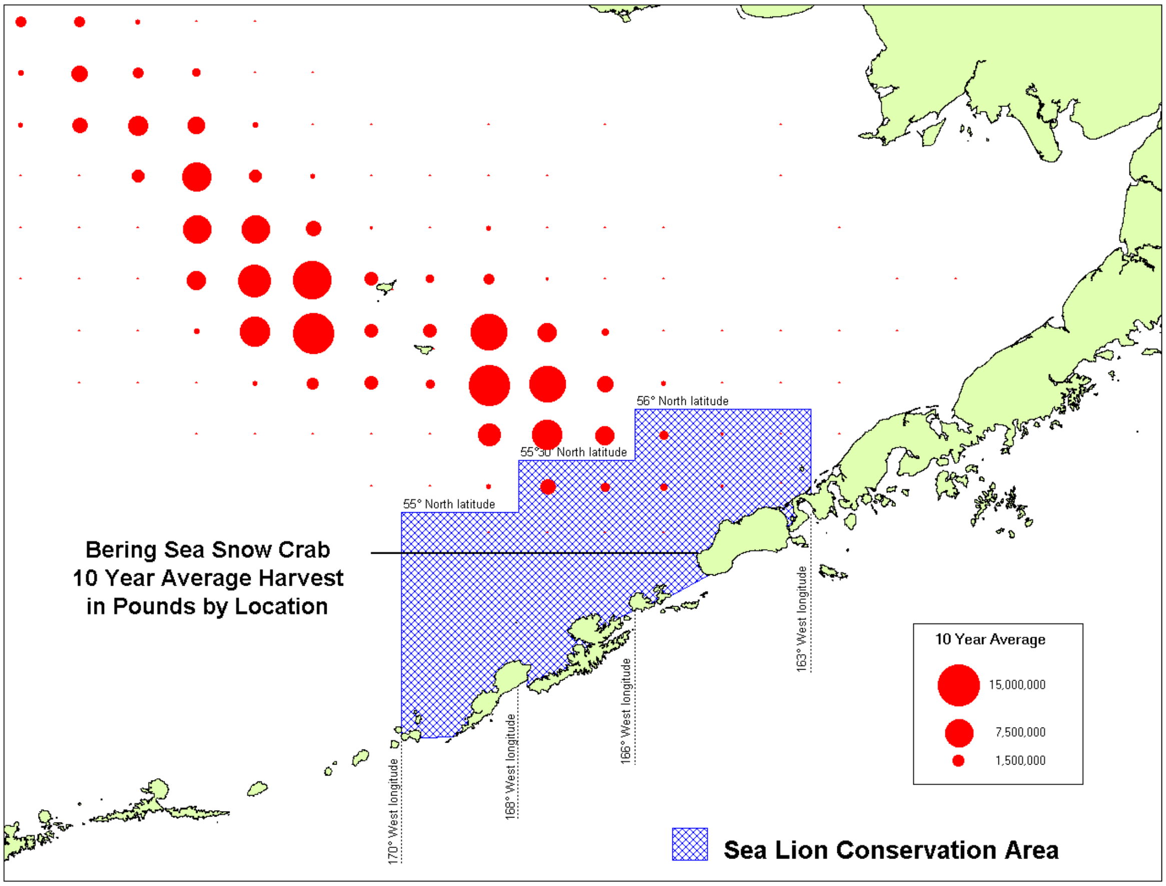
Steller Sea Lion Protection Zones - August 1993



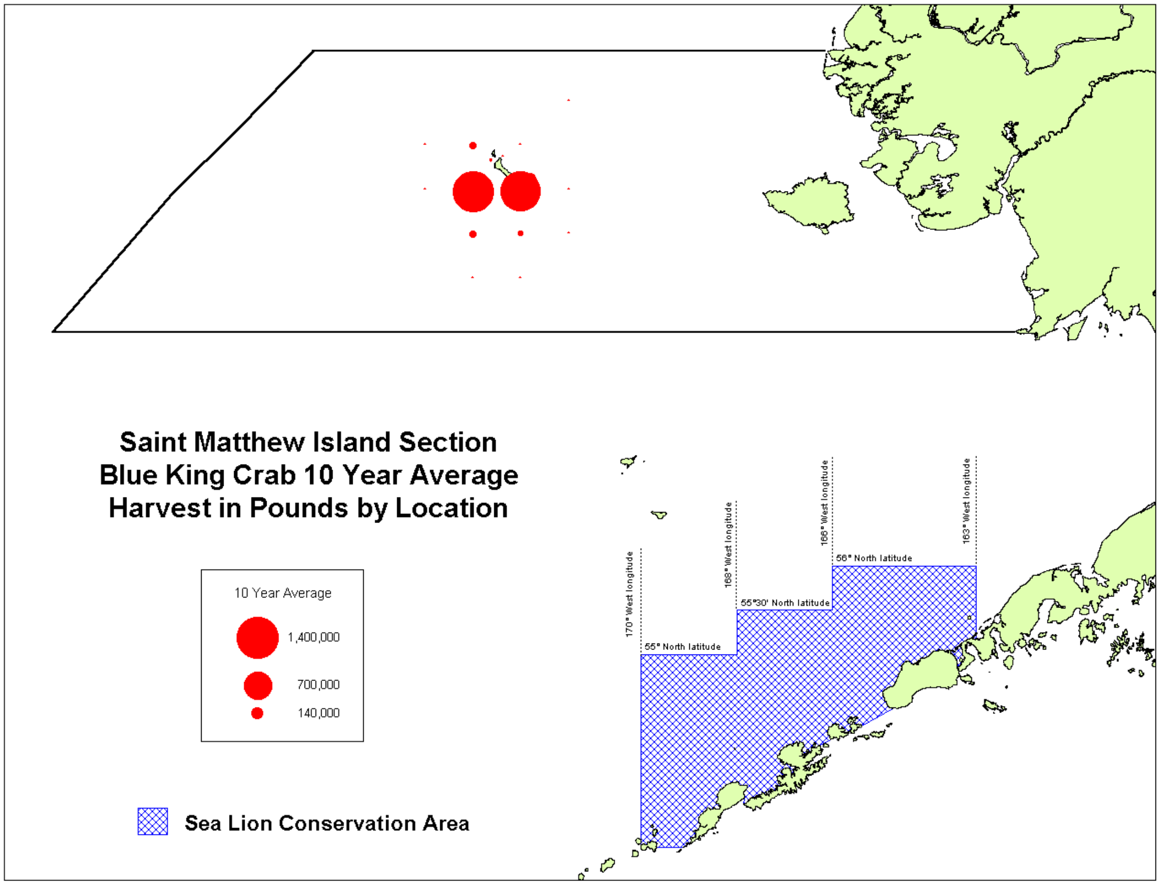
Map 1: Steller Sea Lion Critical Habitat



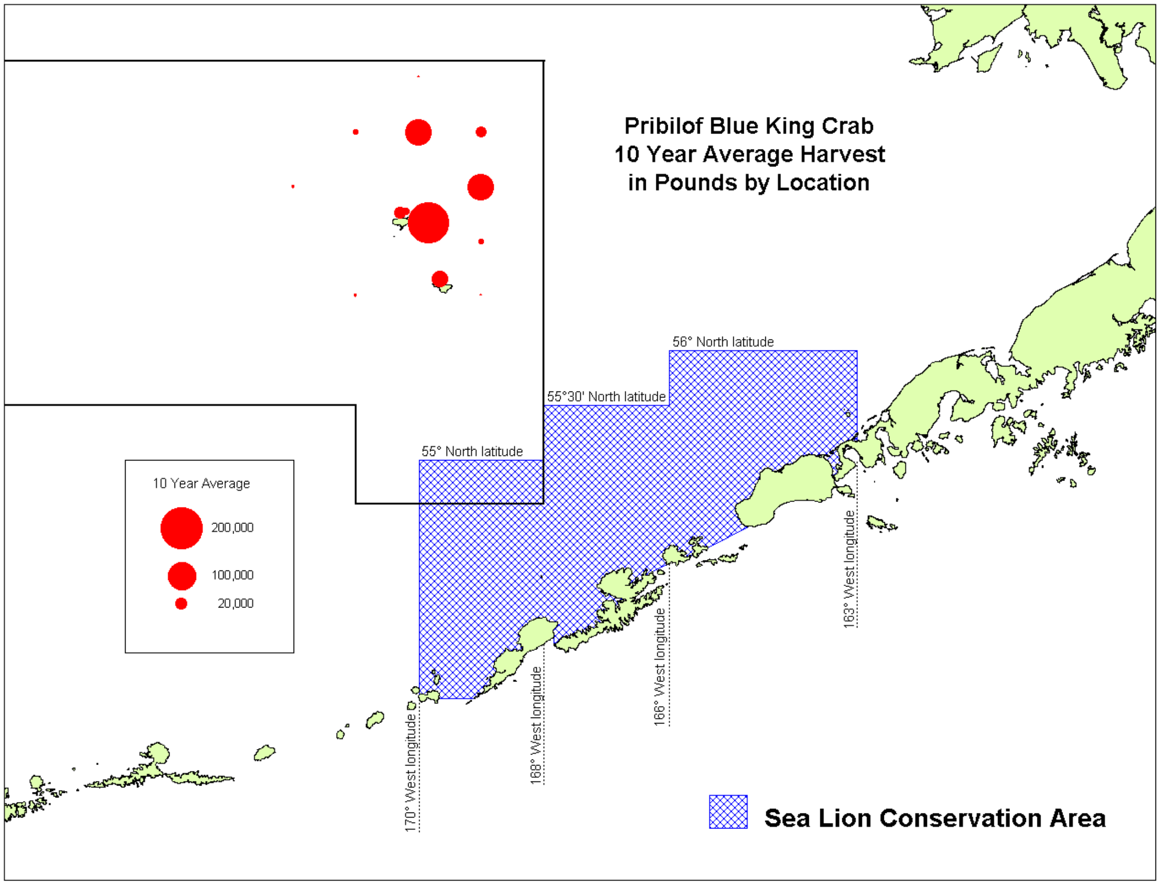
Map 2: Bering Sea Tanner Crab 10 Year Average Harvest in Pounds by Location (courtesy of ADF&G).



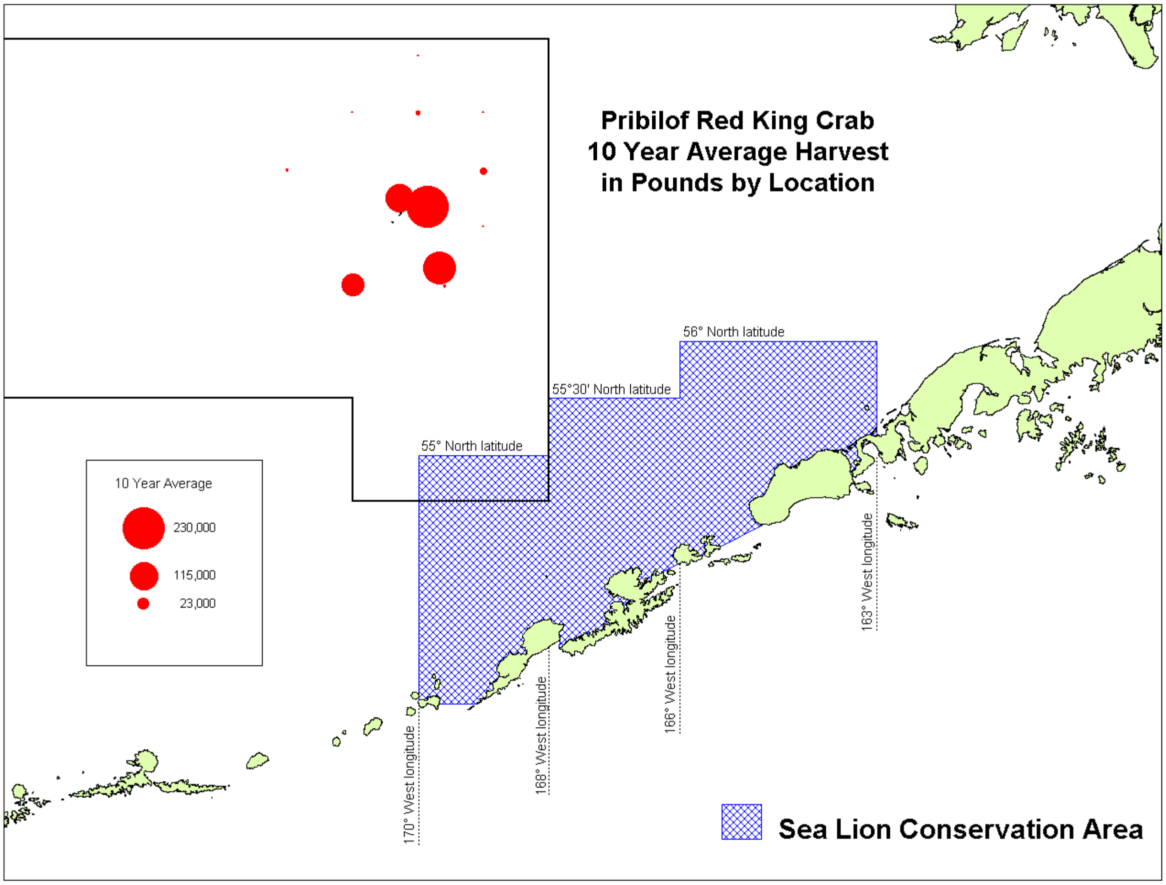
Map 3: Bering Sea Snow Crab 10 Year Average Harvest in Pounds by Location (courtesy of ADF&G).



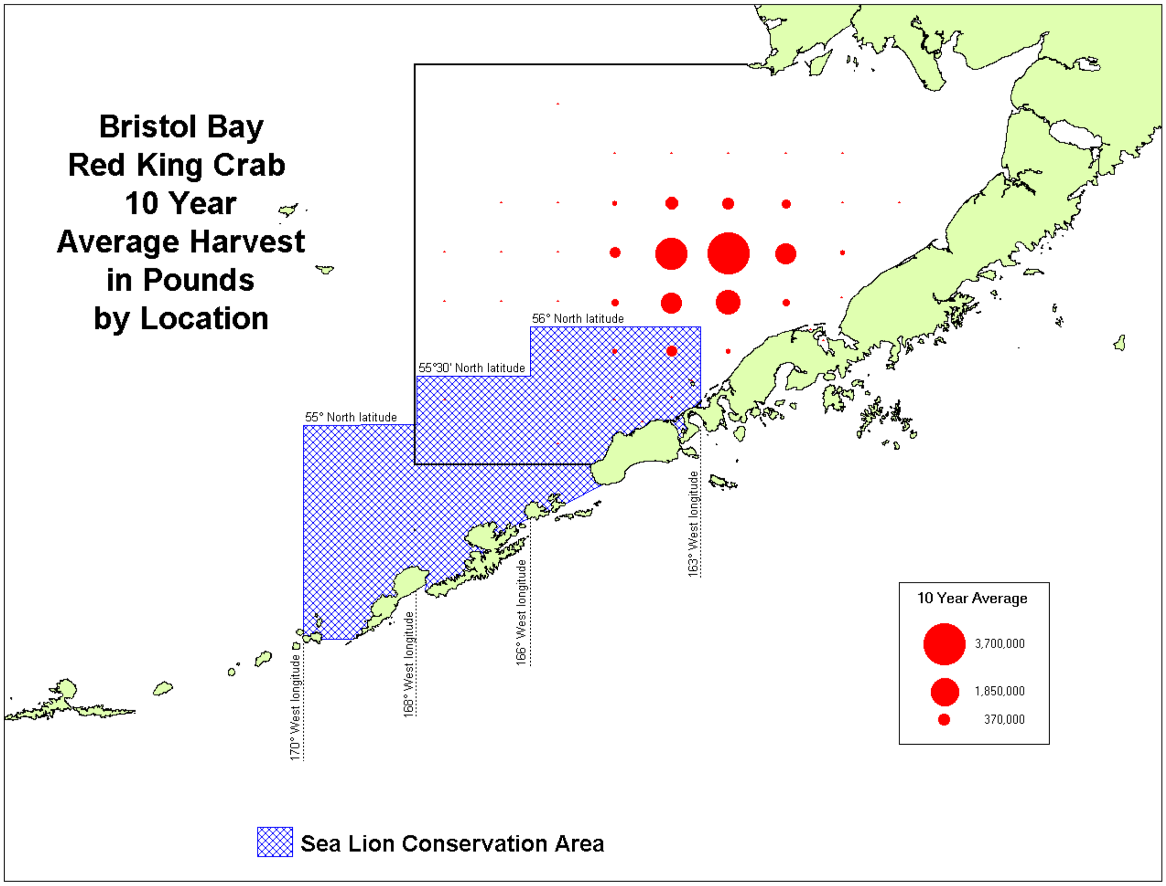
Map 4: Saint Matthew Islands Blue King Crab 10 Year Average Harvest in Pounds by Location (courtesy of ADF&G).



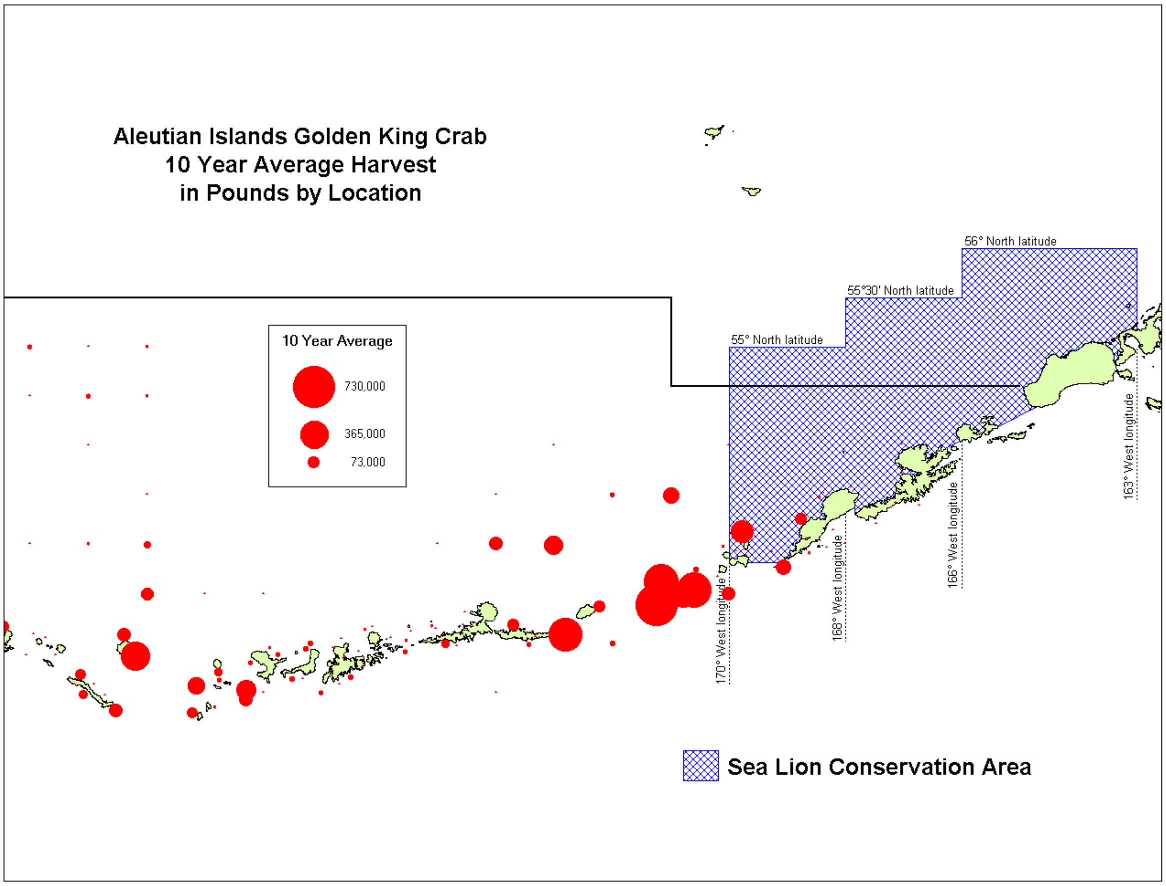
Map 5: Pribilof Blue King Crab 10 Year Average Harvest in Pounds by Location (courtesy of ADF&G).



Map 6: Pribilof Red King Crab 10 Year Average Harvest in Pounds by Location (courtesy of ADF&G).



Map 7: Bristol Bay Red King Crab 10 Year Average Harvest in Pounds by Location (courtesy of ADF&G).



Map 8: Aleutian Islands Golden King Crab 10 Year Average Harvest in Pounds by Location (courtesy of ADF&G).

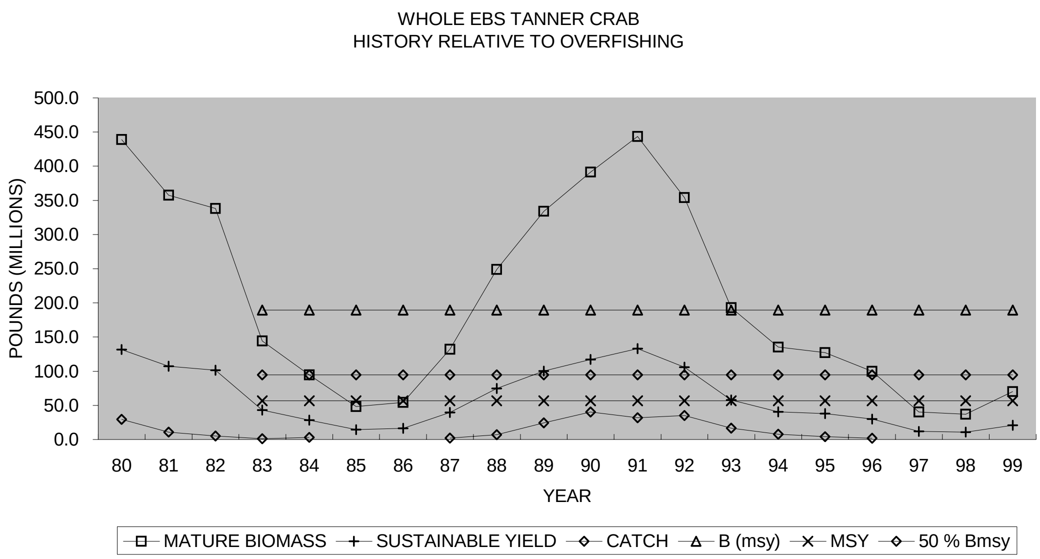


Figure 1: Whole EBS Tanner Crab History Relative to Overfishing (NMFS 2000).

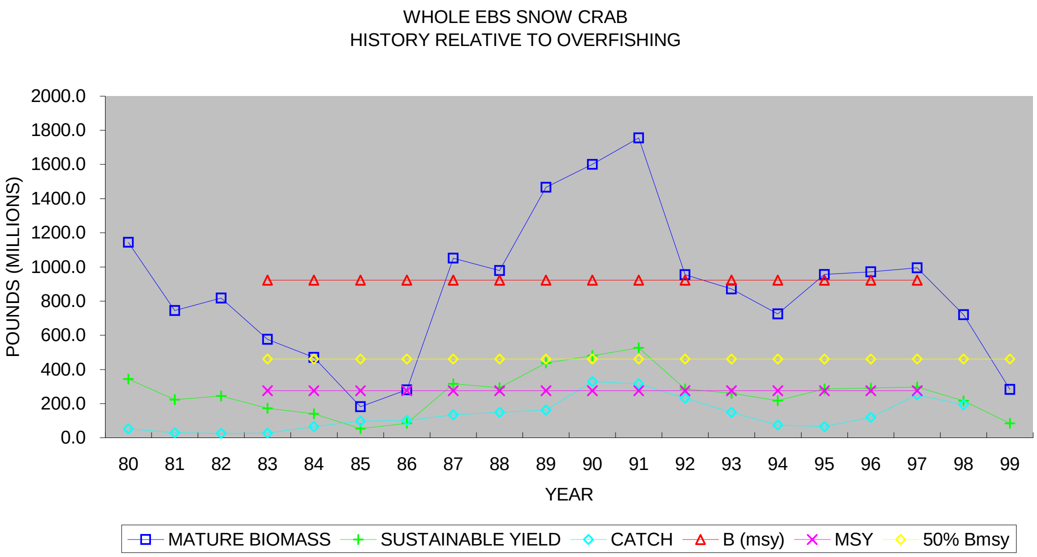


Figure 2: Whole EBS Snow Crab History Relative to Overfishing (NMFS 2000).

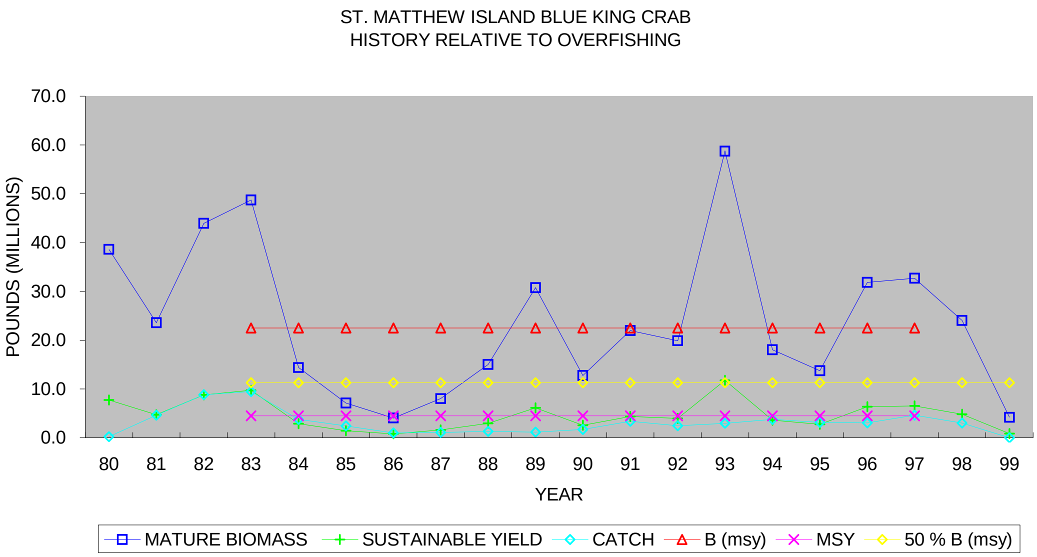


Figure 3: St. Matthew Island Blue King Crab History Relative to Overfishing (NMFS 2000).

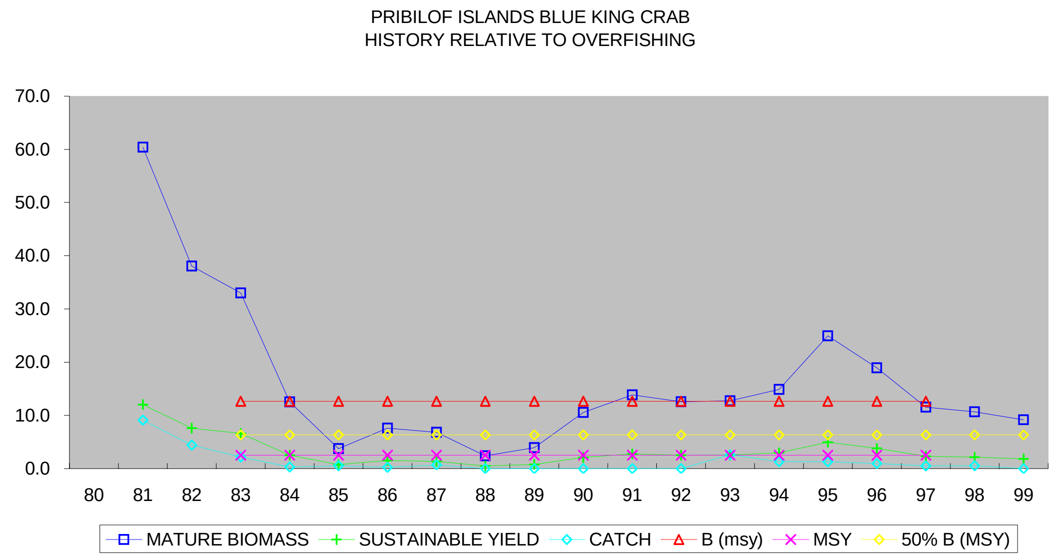


Figure 4: Pribilof Islands Blue King Crab History Relative to Overfishing (NMFS 2000).

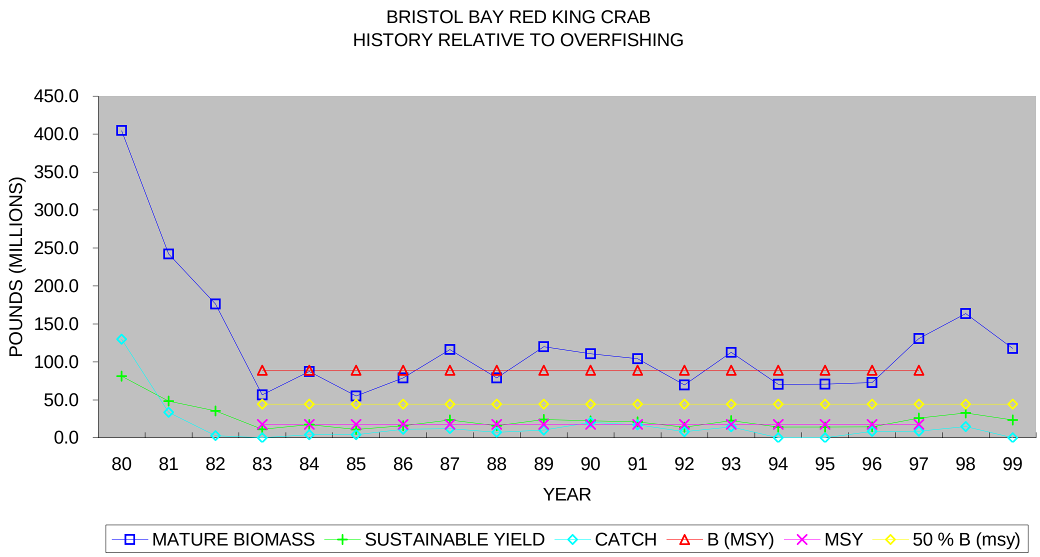


Figure 5: Bristol Bay Red King Crab History Relative to Overfishing (NMFS 2000).

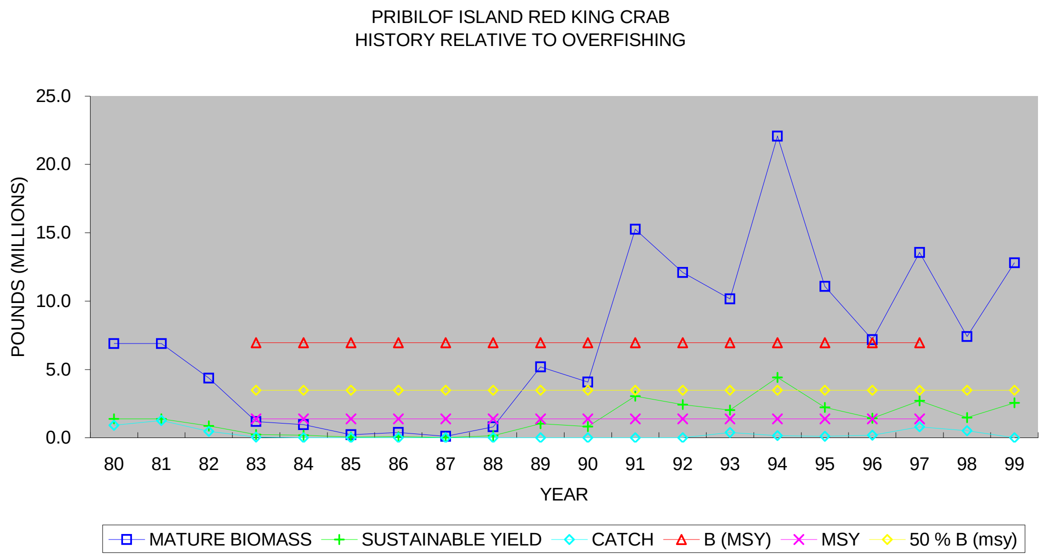


Figure 6: Pribilof Islands Red King Crab History Relative to Overfishing (NMFS 2000).