Section 14

SUMMARY OF CHANGES IN THE BERING SEA-ALEUTIAN ISLANDS
SQUID AND OTHER SPECIES ASSESSMENT

by
Lowell W. Fritz

Relative to the November 1999 SAFE report, the following changes have been made in the current draft of the squid and other species chapter:

1) Catch and survey biomass data are updated.

2) The recommended ABC for squid in the year 2001 is calculated as 0.75 times the average catch from 1978-95, or **1,970 mt**; the recommended overfishing level for squid in the year 2001 is calculated as the average catch from 1978-95, or **2,624 mt.**

3) The recommended ABC for the other species complex in the year 2001 is calculated as the average catch from 1977-99, or **26,500 mt**. The recommended overfishing level for the other species complex in the year 2001 is **113,400 mt**, which was calculated by multiplying an estimate of the natural mortality rate (M=0.2) by a biomass estimate for the complex (average of the last 3 eastern Bering Sea bottom trawl surveys plus the most recent Aleutian Islands bottom trawl survey = 566,900 mt).

SQUID and OTHER SPECIES

by
Lowell W. Fritz

14.1 INTRODUCTION

The "other species" management group has been established to account for species which are currently of slight economic value and upon which there is little, if any, directed fishing. However, these species could have economic value in the future, and many are important components of the ecosystem as prey for commercial fish species, marine mammals and birds. Squid is considered separately from the "other species" management group, which includes sculpins, skates, sharks, and octopus. Smelts were removed from the "other species" group and moved to the forage fish group beginning in 1999 as a result of fishery management plan (FMP) amendments 36 and 39 to the Bering Sea and Aleutian Islands and Gulf of Alaska groundfish FMPs.

Information on the distribution, abundance, and biology of squid stocks in the eastern Bering Sea (EBS) and Aleutian Islands region is limited. The predominate species in commercial catches in the EBS is the red squid, *Berryteuthis magister*, while *Onychoteuthis borealijaponicus*, the boreal clubhook squid, is the principal species encountered in the Aleutian Islands region. Assessment data are not available for squid from Alaska Fishery Science Center surveys because of their pelagic distribution.

During cooperative U.S.-Japan surveys from 1979-85, 41 species of sculpins were identified in the EBS and 22 species in the Aleutian Islands region (Bakkala et al. 1985; Ronholt et al. 1985; Bakkala 1993). During these same surveys, 15 species of skates were identified but inadequate taxonomic keys for this family may have resulted in more species being identified than actually exist. Species that have been consistently identified during surveys are the Alaska skate, (*Bathyraja parmifera*), big skate (*Raja binoculata*), longnose skate *(R. rhina*), starry skate (*R. stellulata)*, and Aleutian skate (*B. aleutica*). Biomass estimates of these species from demersal trawl surveys serve as valuable indices of their relative annual abundance on the eastern Bering Sea shelf.

While biomass estimates have been made for sharks, smelts and octopi, the AFSC bottom trawl surveys fail to adequately sample their habitats. Sharks are rarely taken during demersal trawl surveys in the Bering Sea. Spiny dogfish *(Squalus acanthias*) is the most common species caught, and the Pacific sleeper shark (*Somniosus pacificus*) has been taken on occasion. Smelts are captured during trawl surveys, but their distribution is patchy and sampling with bottom trawl gear is largely incidental. The three species of smelt found in the Bering Sea are capelin (*Mallotus villosus*), rainbow smelt (*Osmerus mordax*), and eulachon (*Thaleichthys pacificus*). Two species of octopus have been recorded, with *Octopus dofleini* predominating and *Opisthoteuthis california* occurring rarely.

14.2 CATCH HISTORY

Squid are generally taken incidentally in target fisheries for groundfish but have been the target of Japanese and Republic of Korea trawl fisheries in the past. Reported catches since 1977 are shown in Table 1. After reaching 9,000 mt in 1978, total squid catches have steadily declined to only a few hundred tons in 1987-95. Thus, squid stocks have been very lightly exploited in recent years. Discard rates of squid (discards/total squid catch) by the BSAI groundfish fisheries have ranged between 40% and 85% in 1992-1998 (NMFS Regional Office, Juneau, AK).

Reported catches of "other species" increased during the 1960's and early 1970's and reached a peak of 133,000 mt in 1972 which was the year when total catches of all species of groundfish reached a maximum of 2.3 million mt. The "other species" catch in 1972 represented 6% of the total groundfish catch. In 1973-76 catches declined to a range of 33,000-70,000 mt annually as total catches of groundfish also declined. Catches of "other species" were relatively high from 1977-1981 (43,000-73,000 mt), but thereafter declined to a range of 5,000-13,000 mt in 1984-89 despite increased catches of total groundfish (Table 2). Part of the reason may be incomplete reporting of domestic catches before 1990. Since 1990, catches have ranged between 17,000 and 33,000 mt, and represented 2% or less of the total groundfish catches from the Bering Sea and Aleutian Islands. From 1992-1998, between 90% and 94% of the "other species" caught were discarded (NMFS Regional Office, Juneau, AK).

Catches of individual species or species group in the "other species" category were estimated using observed bycatch rates by target species fishery, gear, month, and within each statistical subarea in the Bering Sea and Aleutian Islands for 1998. These bycatch rates were applied to actual target species landings by each target species fishery, gear, month, and within each statistical subarea to estimate total "other species" subgroup catches (Table 3). Squid and other species catches estimated in this manner for 1992-97 were generally smaller or nearly equal to the blend totals reported by the NMFS Regional Office (Table 2). In these years, bycatch rates were estimated for each target species fishery, gear and statistical area. For 1998, an additional element, time (month) was added for the determination of bycatch rates. For 1998 (Table 3), the total catch estimate for squid is slightly higher then the blend estimate (1,144 mt vs. 915 mt), but the total catch estimate for other species is significantly higher (41,249 mt vs. 25,531 mt). This latter difference is due almost entirely to catches of skates by other flatfish fisheries; high observed monthly bycatch rates were estimated from a small portion of the fleet and expanded to the entire fleet. These data suggest that, as with any estimate, there is uncertainty in our catch estimates, particularly for non-target species where no product recovery rates are available. Total catches of squid and other species have comprised less than 2% of the total groundfish catches regardless of the data source employed. Locations of observed catches of squid and each of the other species groups by groundfish fisheries from 1990-96 are shown in Figures 1-6 of Fritz (1997).

Skates and sculpins constitute the bulk of the other species catches, accounting for between 66-96% of the estimated totals in 1992-1997. While skates are caught in almost all fisheries and areas of the Bering Sea shelf, most of the skate bycatch is in the hook and line fishery for Pacific cod, with trawl fisheries for pollock, rock sole and yellowfin sole also catching significant amounts. Sculpins are also caught by a wide variety of fisheries, but trawl fisheries for yellowfin sole, Pacific cod, pollock, Atka mackerel and rock sole catch the most. Estimated skate and sculpin bycatches in the BSAI groundfish fisheries have ranged between 1-4% of their respective survey biomasses (Table 4) between 1990 and 1996.

Most squid have been caught as bycatch in the midwater trawl pollock fishery primarily over the shelf break and slope or in deep waters of the Aleutian Basin (subareas 515, 517, 519, 521 and 522).

Bottom trawl pollock and all three of the fisheries for Pacific cod (pots, longlines and trawls) catch almost all of the octopus bycatch. Octopus catches by groundfish fisheries in the BS/AI estimated using observer bycatch rates ranged between 139-1,017 mt in 1992-96. In addition, there is a small directed fishery for octopus in the Aleutian Islands and southwestern Bristol Bay regions. Directed octopus landings from 1988-95 have been less than 8 mt per year (Skip Gish, Alaska Department of Fish and Game, Dutch Harbor, pers. comm.). Harvest rates of octopus (defined as total removals divided by survey biomass) have ranged between 2-10% for each of the years from 1990-94. However, in 1995, removals of 977 mt of octopus from the eastern Bering Sea alone represented 35% of the octopus survey biomass of 2,779 mt. Octopus biomasses in the eastern Bering Sea and Aleutian Islands regions are believed to be underestimated by the bottom trawl surveys due to undersampling in important nearshore, rocky habitats.

Smelts are caught primarily by the yellowfin sole fishery in northern Bristol Bay and by the midwater trawl pollock fishery along the outer shelf northwest of Unimak Island. Capelin and rainbow smelt are primarily caught by the yellowfin sole fishery on the inner and middle shelf, while eulachon are caught principally by the pelagic pollock fishery operating between the Pribilof Islands and Unimak Island on the outer shelf and slope. Estimated smelt bycatches in the BSAI groundfish fisheries, as percentages of smelt survey biomass estimates, were less than 3% in 1992-94 and 1996, but were over 10% in 1995. However, smelt survey biomass estimates from the bottom trawl survey are highly variable and unreliable.

Estimates of shark bycatch in the BS/AI groundfish fisheries from 1992-96 have ranged from 308-702 mt. Most of the shark bycatch occurs in the midwater trawl pollock fishery and in the hook and line fisheries for sablefish, Greenland turbot and Pacific cod along the outer continental shelf and slope of the Bering Sea (subareas 517, 515 and 521). Bottom trawl surveys do not adequately sample sharks, reducing the utility of biomass estimates (Table 4) as indicators of abundance.

Grenadiers, while not part of the other species category, are a significant bycatch species in the sablefish and turbot longline fisheries on the outer shelf and continental slope regions of the Aleutian Islands and eastern Bering Sea. Total bycatch estimates from 1992-96 have ranged between 2,675 mt (in 1992) and 8,885 (in 1993). Due to the lack of deep stations in eastern Bering Sea trawl surveys after 1985, the best biomass estimates of grenadiers may be from the early 1980s in both the eastern Bering Sea (1982) and Aleutian Islands (1983). If this is the case, current (1992-96) bycatch of grenadiers in the BSAI groundfish fisheries represents between 0.5 and 2% of the grenadier biomass in the BSAI region (Table 4).

14.3 CONDITION OF STOCKS

There is currently no reliable estimate of squid abundance in the eastern Bering Sea. Sobolevsky (1996) cites an estimate of 4 million tons for the entire Bering Sea made by squid biologists at TINRO (Shuntov et al. 1993), and an estimate of 2.3 million tons for the western and central Bering Sea (Radchenko 1992), but admits that squid stock abundance estimates have received little attention. It is clear that the AFSC bottom trawl surveys greatly underestimate squid abundance.

Data from AFSC surveys provide the only abundance estimates for the various groups and species comprising the "other species" category (Table 4). Biomass estimates for the eastern Bering Sea are from a standard survey area of the continental shelf. The 1979, 1981, 1982, 1985, 1988 and 1991 data include estimates from continental slope waters (200-1,000 m in 1979, 1981, 1982, and 1985; 200-800 m in 1988 and 1991), but data from other years do not. Slope estimates were usually 5% or less of the shelf estimates, except for grenadiers. Stations as deep as 900 m were sampled in the 1980, 1983 and 1986 Aleutian Islands bottom trawl surveys, while surveys in 1991 and 1994 obtained samples only to a depth of 500 m. The actual catches made by research vessels upon which the biomass estimates were based are shown in Table 5.

Since the survey biomass estimates for species other than squid vary substantially from year-to-year due to different distributions of the component species, it is probably more reliable to estimate current biomass by averaging estimates of recent surveys. The average biomass of other species (not including squid, smelt, and grenadiers) from the last 3 eastern Bering Sea surveys (1998-2000) is 521,800 mt; adding the estimate from the 2000 Aleutian Islands survey (46,100 mt) yields a total **BS/AI “other species” biomass estimate of 566,900 mt**.

Biomass estimates from AFSC surveys illustrate that sculpins were the major component of this group until 1986, after which the biomass of skates exceeded that of sculpins. The abundance of skates increased between 1985 and 1990 (when a high of 583,800 mt survey biomass was observed), but has since declined to 354,200 mt in 1998; the abundance of sculpins has remained relatively stable over that time period.

However, the 95% confidence interval around the 1990 skate biomass estimate was wider and overlapped those in 1988-89 and 1991, indicating that the estimates did not differ significantly among these four years.

Biomass estimates for the "other species" complex as a whole have fluctuated considerably since 1975, possibly because of changes in availability or vulnerability of the various species to the survey trawls, as well as the depths surveyed (e.g., grenadiers). This is particularly evident for smelts, sharks and octopus, which are poorly sampled by demersal trawls; abundance of these groups may be underestimated. Changes in distribution of particular species also accounts for some of the biomass flucuations of a group. For instance, a cold water sculpin species, the butterfly sculpin (*Hemilepidotus papilio*), has been found to intrude into the northern portion of the survey area to a greater extent in some years than others, and accounts for a major part of the fluctuations in biomass of the sculpin group.

There is some evidence that abundances of smelt (primarily capelin and eulachon) were lower in the 1980s than in the 1970s in the North Pacific and Bering Sea (Fritz et al. 1993; Anderson et al. 1994). This decline may be related to decadal-scale shifts in oceanographic conditions in the North Pacific; surface water temperatures in the 1970s were cooler than those in the 1980s (Niebauer and Hollowed 1993). Recent declines in the sizes of the Steller sea lion and harbor seal populations in the North Pacific may also be linked to changes in abundances of their prey, particularly smelts (NMFS 1993; Fritz et al.1995). It is unclear, however, whether there has been an actual decline in smelt abundance or simply a change in their distribution (e.g. they went deeper to cooler waters), reducing their availability to marine mammals. Groundfish food habits in the Gulf of Alaska in 1990 reveal that capelin were available to groundfish piscivores (e.g., arrowtooth flounder), with an estimated 329,000 mt of capelin consumed (Livingston, in prep.).

14.4. MAXIMUM SUSTAINABLE YIELD

Maximum sustainable yield (MSY) for squid and other species is unknown.

14.5 ACCEPTABLE BIOLOGICAL CATCH

Squid **-** Given the lack of data on their population dynamics and current biomass, the acceptable biological catch (ABC) for squid should be set using the criteria in Tier 6 of the revised ABC and overfishing level (OFL) definitions contained in Amendment 44 to the BSAI FMP: ABC $\leq$ 75% of the average catch from 1978-95. Thus, **the recommended ABC for squid in the year 2001 is 0.75 x 2,624 = 1,970 mt**.

Other Species **-** There are reliable biomass estimates for many of the species groups that comprise the other species category, and most of the other species catches (e.g. skates and sculpins). A single estimate of M for this diverse assemblage, while not known, may be conservatively estimated at 0.2. This suggests that ABC and OFL for the other species assemblage could be set using the criteria in Tier 5 of the revised ABC and OFL definitions contained in Amendment 44, where F_{OFL}=M, and $F_{ABC} \leq 0.75$ x M. If both ABC and OFL are set using Tier 5 criteria, then OFL=566,900 x 0.2 = 113,400 mt, and ABC would be capped at 85,050 mt, an increase in annual catch of over 3-fold over recent (since 1982) years if it all were caught. At this time, however, there is no compelling reason to so radically alter the method of computing the ABC for the other species complex from that recommended in last year’s assessment, where ABC was set equal to the average catch since 1977 (1977-99). Thus, **the recommended ABC for the other species complex in the year 2001 is 26,500 mt**.

An ABC set at this level for the other species category represents an exploitation rate of about 5% of current biomass (566,900 mt).

14.6 OVERFISHING LEVEL

Squid **-** Using Tier 6 criteria, **the recommended overfishing level for squid in the year 2001 is 2,624 mt,** the average annual catch from 1978-95 in the BS/AI.

Other species **-** Using Tier 6 criteria, the overfishing level for the other species complex would be set at the average annual catch from 1978-95, or 25,760 mt. There is some likelihood that an overfishing level set this low for the other species complex could unnecessarily constrain other fisheries, since catches over 33,000 mt were achieved as recently as 1992. Using Tier 6 criteria would also set the OFL at a level of only about 5% of current biomass, which may be unnecessarily low for this untargeted group. Therefore, it is recommended that OFL be set using Tier 5 criteria, where F_{OFL}=M, M=0.2, and OFL=0.2 x 566,900 mt, the most current estimate of biomass of the other species group; **the recommended 2001 overfishing level for the other species complex in the year 2000 is 113,400 mt**.

14.7 YIELD DETERMINATIONS FOR NEPA ANALYSIS

Stock assessment authors were requested to address the following alternatives in our chapters for use in the preparation of an Environmental Assessment for the 2001 TAC specifications. In each case, authors were requested to compute fishing mortality rate (F) estimates and project 5 years into the future on yield and biomass. Since the "other species" and squid assessments do not use models, projections are not possible, nor are calculations of F. Therefore, yield calculations under each alternative are provided only for the year 2000.

A) Maximum permissible ABC:	
Squid (75% of average catch from 1978-95; Tier 6)	1,970 mt
Other Species (75% of M x Biomass; Tier 5)	85,000 mt
B) Recommended ABC:	
Squid (75% of average catch from 1978-95; Tier 6)	1,970 mt
Other Species (Average catch 1977-present)	26,500 mt
C) 5-year average catch:	
Squid	880 mt
Other Species	23,000 mt
D) 50% of maximum permissible ABC:	
Squid	985 mt
Other Species	42,500 mt
E) ABC=0	
Squid	0 mt
Other Species	0 mt

14.8 ECOSYSTEM CONSIDERATIONS

Many species in the squid and other species assemblage are important as prey for marine mammals and birds as well as commercial groundfish species. Smelts are prey for all three groups. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Changes in breeding success of seabirds has been correlated with changes in the availability of prey, both in Alaska and elsewhere (Hunt et al. 1981b; Furness 1982, 1984; Murphy et al. 1984). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987; Wespestad 1987). Smelts also comprise significant portions of the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon, throughout the North Pacific Ocean and the Bering Sea (Allen 1987; Yang 1993; Livingston, in prep.).

Squid and octopus are consumed primarily by marine mammals, such as Steller sea lions (Lowry et al. 1982), northern fur seals (Perez and Bigg 1986), harbor seals (Pitcher 1980; Lowry et al. 1982), sperm whales (Kawakami 1980), Dall's porpoise (Crawford 1981), and Pacific white-sided dolphins (Morris et al. 1983) and beaked whales (Loughlin and Perez 1985). Sculpins have also been found in the diet of harbor seals (Lowry et al. 1982).

The species groups that currently comprise the bulk (92-96% from 1990-98) of the other species catch, skates and sculpins, are not important prey species for marine mammals or birds. Three other species groups, smelts, squid, and octopus, are important prey for marine mammals and birds, but comprise a smaller fraction of the catches by weight. While catches of smelts and cephalopods are currently at low levels compared to the best estimates of their biomasses, confidence in these biomass estimates is low. There is no reliable information on recent trends in octopus or squid biomass, and the only information on smelt biomass trends suggests that they may have declined in recent years. If there is any significant directed fishing on any component of the other species group, particularly those that serve as prey for marine mammals and birds, then future assessments should reflect this change by setting separate ABCs for those species or species groups. Currently, the potential for the establishment of directed forage fish fisheries has been limited by the Council through the adoption of Amendments 36 and 39 to the BSAI and GOA Fishery Management Plans, respectively. Catches of forage fish will be limited to a maximum retainable bycatch of 2% of the groundfish species catches. This would allow for bycatch within the current groundfish fisheries, but limit the total amount of forage fish that can be retained.

14.9 REFERENCES

Allen, M. J. 1987. Demersal fish predators of pelagic forage fishes in the southeastern Bering Sea. Pp. 29-32 In Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Anderson, P. J., S. A. Payne, and B. A. Johnson. 1994. Long-term demersal community structure changes in Pavlof Bay, Alaska. Unpubl. manuscr., 28 p. NMFS-AFSC Kodiak Lab, P.O. Box 1638, Kodiak, AK 99615.

Bakkala, R. G. 1993. Structure and historical changes in the groundfish complex of the eastern Bering Sea. U.S. Dept. Commerc., NOAA Technical Report NMFS 114, 91 p.

Bakkala, R. G., J. Traynor, K. Teshima, A. M. Shimada, and H. Yamaguchi. 1985. Results of cooperative U.S. -Japan groundfish investigations in the eastern Bering Sea during June-November 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-87, 448 p.

Crawford, T. W. 1981. Vertebrate prey of *Phocoenoides dalli* (Dall's porpoise), associated with the Japanese hign seas salmon fishery in the North Pacific Ocean. M.S. Thesis, Univ. Washington, Seattle, 72 p.

Fritz, L. W. 1997. Squid and other species. Pp. 463-484 In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501.

Fritz, L. W., V. G. Wespestad, and J. S. Collie. 1993. Distribution and abundance trends of forage fishes in the Bering Sea and Gulf of Alaska. Pp. 30-44 In Is It Food: Addressing marine mammal and seabird declines. Workshop Summary. Alaska Sea Grant College Program Rept. No. AK-SG-93-01, Univ. Alaska, Fairbanks, AK 99775-5040.

Fritz, L. W., R. C. Ferrero, and R. J. Berg. 1995. The threatened status of Steller sea lions under the Endangered Species Act: effects on Alaskan groundfish fisheries management. Mar. Fisheries Review 57(2): 14-27.

Frost, K. J. and L. Lowry. 1987. Marine mammals and forage fishes in the southeastern Bering Sea. Pp. 11-18 In Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Furness, R. W. 1982. Competition between fisheries and seabird communities. Advances in Marine Biology 20: 225-307.

Furness, R. W. 1984. Seabird-fisheries relationships in the northeast Atlantic and North Sea. Pp. 162-169 In D. N. Nettleship, G. A. Sanger, and P. F. Springer (eds.), Marine Birds: their feeding ecology and commercial fisheries relationship. Canadian Wildlife Service, Publ. No. CW66-65/1984.

Hunt, G. L., Jr., B. Burgeson, and G. A. Sanger. 1981a. Feeding ecology of seabirds of the eastern Bering Sea. Pp 629-647 In D. W. Hood and J. A. Calder (eds.), The Eastern Bering Sea Shelf: Oceanography and Resources, Vol. II. U. S. Dept. Commerc., NOAA, OCSEAP, Office of Marine Pollution Assessment, Univ. WA Press, Seattle, WA.

Hunt, G. L., Jr., Z. Eppley, B. Burgeson, and R. Squibb. 1981b. Reproductive ecology, foods and foraging areas of seabirds nesting on the Pribilof Islands, 1975-79. Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, RU-83, U. S. Dept. Commerc., NOAA, OCSEAP, Boulder, CO.

Kawakami, T. 1980. A review of sperm whale food. Sci. Rep. Whales Res. Inst. Tokyo 32: 199-218.

Livingston, P. A. Groundfish utilization of walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasi*) and capelin (*Mallotus villosus*) resources in the Gulf of Alaska. In preparation.

Loughlin, T. R., and M. A. Perez. 1985. *Mesoplodon stejnegeri*. Mamm. Species 250: 1-6.

Lowry, L. F., K. J. Frost, D. G. Calkins, G. L. Swartzman and S. Hills. 1982. Feeding habits, food requirements and status of Bering Sea marine mammals. Counc. Doc. Nos. 19 and 19A (annotated bibliography), 574 p. North Pacific Fisheries Management Council, P. O. Box 103136, Anchorage, AK 99510.

Morris, B. F., M. S. Alton, and H. W. Braham. 1983. Living marine resources of the Gulf of Alaska: a resource assessment for the Gulf of Alaska/Cook Inlet Proposed Oil and Gas Lease Sale 88. U.S. Dept. Commerc., NOAA, NMFS.

Murphy, E. C., R. H. Day, K. L. Oakley, A. A. Hoover. 1984. Dietary changes and poor reproductive performances in glaucous-winged gulls. Auk 101: 532-541.

Niebauer, H. J., and A. B. Hollowed. 1993. Speculations on the connection of atmospheric and oceanic variability to recruitment of marine fish stocks in Alaska waters. Pp. 45-53 In Is It Food: Addressing marine mammal and seabird declines. Workshop Summary. Alaska Sea Grant College Program Rept. No. AK-SG-93-01, Univ. Alaska, Fairbanks, AK 99775-5040.

National Marine Fisheries Service. 1993. Final recovery plan for Steller sea lions *Eumetopias jubatus*. U.S. Dept. Commerc., NOAA, NMFS. Silver Spring, MS. 92 p.

Perez, M. A. and M. A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North America. Fish. Bull., U.S. 84: 957-971.

Pitcher, K. W. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. Fish. Bull., U.S. 78: 544-549.

Radchenko, V.I. 1992. The role of squid in the pelagic ecosystem of the Bering Sea. Okeanologiya 32(6): 1093-1101. (In Russian).

Ronholt, L. L., K. Wakabayashi, T. K. Wilderbuer, H. Yamaguchi, and K. Okada. 1985. Results of the cooperative U.S.-Japan groundfish resource assessment survey in Aleutian Islands water, June-November 1980. Unpubl. manuscr., 303 p. Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE, Bin C15700, Seattle, WA 98115.

Sanger, G. A. 1983. Diets and food web relationships of seabirds in the Gulf of Alaska and adjacent marine regions. Outer Continental Shelf Environmental Assessment Program, Final Reports of Prinicipal Investigators 45: 631-771.

Shuntov, V.P., A. F. Volkov, O. S. Temnykh, and Ye. P. Dulepova. 1993. Pollock in the ecosystem of the far eastern seas. Tikhookean. Nauchno-Issled. Inst. Rybn. Khoz. Okeanogr. (TINRO), Vladivostok, 426 pp. (In Russian).

Sobolevsky, Ye. I. 1996. Species composition and distribution of squids in the western Bering Sea. Pp. 135-141 in O. A. Mathisen and K. O. Coyle (eds.)., Ecology of the Bering Sea: a review of Russian literature. Alaska Sea Grant College Program Report No. 96-01, Univ. Alaska, Fairbanks, AK 99775-5040.

Wespestad, V. G. 1987. Population dynamics of Pacific herring (*Clupea palasii*), capelin (*Mallotus villosus*), and other coastal pelagic fishes in the eastern Bering Sea. Pp. 55-60 In Forage fishes of the southeastern Bering Sea. Proceedings of a Conference, November 1986, Anchorage, AK. U.S. Dept Interior, Minerals Management Service, OCS Study MMS 87-0017.

Yang, M. S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990. U.S. Dept. Commerc., NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.

Table 1. Estimated total (retained and discarded) catches of squid (mt) in the eastern Bering Sea and Aleutian Islands by groundfish fisheries, 1977-2000. JV=Joint ventures between domestic catcher boats and foreign processors.

Year	Eastern Bering Sea				Aleutian Islands				Grand Total
	Foreign	JV	Domestic	Total	Foreign	JV	Domestic	Total	
1977	4,926			4,926	1,808			1,808	6,734
1978	6,886			6,886	2,085			2,085	8,971
1979	4,286			4,286	2,252			2,252	6,538
1980	4,040			4,040	2,332			2,332	6,372
1981	4,178	4		4,182	1,763			1,763	5,945
1982	3,833	5		3,838	1,201			1,201	5,039
1983	3,461	9		3,470	509	1		510	3,980
1984	2,797	27		2,824	336	7		343	3,167
1985	1,583	28		1,611	5	4		9	1,620
1986	829	19		848	1	19		20	868
1987	96	12	1	109		23	1	24	131
1988		168	246	414		3		3	417
1989		106	194	300		1	5	6	306
1990			532	532			94	94	626
1991			544	544			88	88	632
1992			819	819			61	61	880
1993			611	611			72	72	683
1994			517	517			87	87	604
1995			364	364			95	95	459
1996			1,083	1,083			84	84	1,167
1997			1,403	1,403			71	71	1,474
1998			891	891			25	25	915
1999									411
2000*									333

*2000 catch reported through October 21, 2000.

Data Sources: Foreign and JV catches-U.S. Foreign Fisheries Observer Program, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, BIN C15700, Bld.4, 7600 Sand Point Way NE, Seattle, WA 98115. Domestic catches before 1989 (retained only; do not include discards): Pacific Fishery Information Network (PacFIN), Pacific Marine Fisheries Commission, Portland, OR 97201. Domestic catches since 1989: NMFS Regional Office, Juneau, AK 99801.

Table 2. Estimated total (retained and discarded) catches of other species (mt) in the eastern Bering Sea and Aleutian Islands by groundfish fisheries, 1977-1999. JV=Joint ventures between domestic catcher boats and foreign processors. Estimated catches of other species from 1977-98 include smelts.

Year	Eastern Bering Sea				Aleutian Islands				Grand Total
	Foreign	JV	Domestic	Total	Foreign	JV	Domestic	Total	
1977	35,902			35,902	16,170			16,170	52,072
1978	61,537			61,537	12,436			12,436	73,973
1979	38,767			38,767	12,934			12,934	51,701
1980	33,955	678		34,633	13,028			13,028	47,661
1981	32,363	3,138	100	35,651	7,028	246		7,274	42,925
1982	17,480	720		18,200	4,781	386		5,167	23,367
1983	11,062	1,139	3,264	15,465	3,193	439	43	3,675	19,140
1984	7,349	1,159		8,508	184	1,486		1,670	10,178
1985	6,243	4,365	895	11,503	40	1,978	32	2,050	13,553
1986	4,043	6,115	313	10,471	1	1,442	66	1,509	11,980
1987	2,673	4,977	919	8,569		1,144	11	1,155	9,724
1988		11,559	647	12,206		281	156	437	12,643
1989		4,695	298	4,993		1	107	108	5,101
1990			16,115	16,115			4,693	4,693	20,808
1991			16,261	16,261			938	938	17,199
1992			29,994	29,994			3,081	3,081	33,075
1993			20,574	20,574			3,277	3,277	23,851
1994			23,456	23,456			1,099	1,099	24,555
1995			20,923	20,923			1,290	1,290	22,213
1996			19,733	19,733			1,706	1,706	21,440
1997			23,656	23,656			1,520	1,520	25,176
1998			23,077	23,077			2,455	2,455	25,531
1999									20,584
2000*									21,685

*2000 catch reported through October 21, 2000.

Data Sources: Foreign and JV catches-U.S. Foreign Fisheries Observer Program, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, BIN C15700, Bld.4, 7600 Sand Point Way NE, Seattle, WA 98115. Domestic catches before 1989 (retained only; do not include discards): Pacific Fishery Information Network (PacFIN), Pacific Marine Fisheries Commission, Portland, OR 97201. Domestic catches since 1989: NMFS Regional Office, Juneau, AK 99801.

Table 3. Estimated catches (mt; retained and discarded) of other species and squid by the eastern Bering Sea (A) and Aleutian Islands (B) groundfish fisheries in 1998 using observer target fishery, gear, and month, and subarea bycatch rates and NMFS blend target species catches. "-" = <0.1 mt; "0" = <0.5 mt.

A. Eastern Bering Sea

		Other Species (mt)					
Target	Gear	Skates	Sharks	Sculpins	Octopus	Total Others	Squid
Atka mackerel	Trawl	2	-	3	-	5	0
Pollock (bottom)	Trawl	78	15	50	0	144	76
Pacific cod	Trawl	537	26	908	12	1,483	0
Pacific cod	Pot	0	-	280	120	400	0
Pacific cod	Jig	-	-	-	-	-	-
Pacific cod	Hook&line	12,991	157	950	14	14,112	0
Pacific cod	ALL	13,528	183	2,138	146	15,995	0
Other flatfish	Trawl	12,475	26	6,539	49	19,088	49
Other flatfish	Hook&line	8	0	0	-	8	-
Other flatfish	ALL	12,482	26	6,539	49	19,096	49
Rockfish	Trawl	5	-	1	-	6	0
Rockfish	Jig	-	-	-	-	-	-
Rockfish	Hook&line	0	0	-	-	0	-
Rockfish	ALL	5	0	1	-	6	0
Other	Hook&line	-	-	-	-	-	-
Pollock (pelagic)	Trawl	218	73	76	2	370	978
Rock sole	Trawl	432	1	130	5	568	0
Sablefish	Trawl	0	-	0	-	0	0
Sablefish	Hook&line	22	6	-	-	28	-
Sablefish	ALL	22	6	0	-	28	0
Greenland turbot	Trawl	13	2	1	0	16	2
Greenland turbot	Pot	-	-	-	-	-	-
Greenland turbot	Hook&line	215	147	1	0	363	-
Greenland turbot	ALL	228	149	2	0	379	2
Yellowfin sole	Trawl	1,172	0	1,242	0	2,415	0
ALL	ALL	28,167	454	10,182	203	39,005	1,106

B. Aleutian Islands and EBS/AI Total

			Other Species (mt)					
Target	Gear	Area	Skates	Sharks	Sculpins	Octopus	Total Others	Squid
Atka mackerel	Trawl	541	39	13	40	-	93	0
Atka mackerel	Trawl	542	25	-	203	0	228	6
Atka mackerel	Trawl	543	29	-	40	3	71	1
Atka mackerel	Trawl	AI	93	-	283	3	378	7
Greenland turbot	Hook&line	541	19	0	0	0	19	-
Greenland turbot	Hook&line	542	23	2	0	0	25	-
Greenland turbot	Hook&line	AI	43	-	-	0	43	-
Pacific cod	Trawl	541	109	-	177	2	289	3
Pacific cod	Trawl	542	12	-	15	-	26	0
Pacific cod	Pot	541	-	-	6	4	10	-
Pacific cod	Pot	542	-	-	5	10	14	-
Pacific cod	Hook&line	541	395	1	354	11	762	-
Pacific cod	Hook&line	542	262	0	213	9	484	0
Pacific cod	Hook&line	543	60	0	40	1	101	-
Pacific cod	ALL	541	505	1	538	18	1,061	3
Pacific cod	ALL	542	273	0	233	18	524	0
Pacific cod	ALL	543	60	0	40	1	101	-
Pacific cod	ALL	AI	839	1	810	37	1,686	3
Pollock (Pelagic)	Trawl	541	0	-	0	-	0	6
Pollock (Pelagic)	Trawl	542	-	0	-	0	0	11
Pollock (Pelagic)	Trawl	543	-	1	-	0	1	9
Pollock (Pelagic)	Trawl	AI	-	-	-	0	0	27
Rockfish	Trawl	541	8	-	7	-	15	0
Rockfish	Trawl	542	6	-	5	-	10	0
Rockfish	Trawl	543	21	-	7	0	28	0
Rockfish	Hook&line	542	11	-	-	-	11	-
Rockfish	ALL	541	8	-	7	-	15	0
Rockfish	ALL	542	16	-	5	-	21	0
Rockfish	ALL	543	21	-	7	0	28	0
Rockfish	ALL	AI	45	-	19	0	64	1
Sablefish	Hook&line	541	25	9	0	0	33	-
Sablefish	Hook&line	542	21	-	-	-	21	-
Sablefish	Hook&line	543	-	-	-	-	-	-
Sablefish	Hook&line	AI	46	9	0	0	54	-
ALL	ALL	541	595	23	585	18	1,221	9
ALL	ALL	542	359	2	440	18	820	17
ALL	ALL	543	110	1	87	4	202	11
ALL	ALL	AI	1,065	26	1,112	40	2,243	38
ALL	**ALL**	**EBS & AI**	**29,232**	**480**	**11,294**	**243**	**41,249**	**1,144**

Table 4. Biomass estimates (mt) in the Eastern Bering Sea and Aleutian Islands of various species assemblages in the "Other Species" category from bottom trawl surveys conducted by the Alaska Fisheries Science Center. Biomass estimates of grenadiers are shown, but the group is not part of the other species assemblage, nor included in the Total column.

Year	Sculpins	Skates	Sharks	Octopus	Total	Smelts	Grenadiers
Eastern Bering Sea							
1975	109,800	31,800	0	5,800	**147,400**	19,200	
1979	296,100	74,400	400	40,300	**411,200**	10,400	91,500
1980	294,400	123,100	0	20,400	**437,900**	13,000	
1981	201,400	127,400	0	10,800	**339,600**	5,700	90,500
1982	336,100	173,200	0	13,100	**522,400**	10,700	104,700
1983	289,700	166,000	400	10,400	**466,500**	5,800	
1984	242,900	190,500	0	2,600	**436,000**	10,500	
1985	174,700	154,000	50	2,800	**331,550**	2,700	107,600
1986	302,100	258,000	0	500	**560,600**	12,500	
1987	194,800	350,800	200	8,000	**553,800**	2,900	
1988	239,800	452,100	5,900	10,500	**708,300**	5,600	61,400
1989	211,700	414,000	0	5,000	**630,700**	1,800	
1990	225,200	583,800	0	11,700	**820,700**	6,700	
1991	275,000	467,300	2,200	8,000	**752,500**	9,900	38,100
1992	223,800	377,500	2,600	5,300	**609,200**	8,300	
1993	215,900	375,000	0	1,400	**592,300**	26,100	
1994	263,000	414,200	5,000	2,200	**684,400**	6,700	
1995	218,700	391,800	1,000	2,800	**614,300**	7,700	
1996	187,800	423,900	2,800	1,700	**616,200**	4,700	
1997	215,800	393,700	0	200	**609,700**	9,000	
1998	197,700	354,200	2,400	1,200	**555,500**	5,300	
1999	146,200	370,500	2,100	800	**519,600**	3,600	
2000	161,350	325,500	1,500	2,000	**496,900**	6,500	
Aleutian Islands							
1980	33,600	10,100	800	800	**45,300**	0	322,400
1983	24,600	16,300	0	400	**41,300**	0	364,100
1986	32,200	19,500	0	0	**51,700**	1,800	618,100
1991	15,900	15,000	2,900	1,100	**35,000**	100	
1994	17,200	25,000	400	1,700	**44,300**	4,900	
1997	13,700	28,900	2,500	1,200	**46,300**	100	
2000	13,000	29,100	2,300	800	**45,100**	1,000	

Table 5. Catches (mt) of other species (skates, sharks, sculpins, and octopus) and squid by research vessels conducting surveys in the eastern Bering Sea (EBS) and Aleutian Islands (AI), 1977-98. The total for the Bering Sea/Aleutian Island region (BSAI) is also shown. These catches were used to calculate the biomass estimates shown in Table 4.

	Skates			Sharks			Sculpins			Octopus			Squid		
Year	EBS	AI	BSAI	EBS	AI	BSAI	EBS	AI	BSAI	EBS	AI	BSAI	EBS	AI	BSAI
1977	0.97	-	0.97	0.00	-	0.00	5.80	-	5.80	0.10	-	0.10	0.00	-	0.00
1978	2.48	-	2.48	-	-	-	11.80	-	11.80	0.30	-	0.30	0.09	-	0.09
1979	5.63	-	5.63	0.03	-	0.03	19.15	-	19.15	2.11	-	2.11	9.10	-	9.10
1980	4.31	6.21	10.52	0.00	0.30	0.30	10.40	13.90	24.30	0.38	0.85	1.23	0.01	19.77	19.78
1981	9.60	-	9.60	0.07	-	0.07	17.19	-	17.19	1.08	-	1.08	7.45	-	7.45
1982	16.17	0.83	17.00	0.16	0.02	0.18	23.68	2.92	26.60	1.00	0.24	1.24	9.61	0.00	9.61
1983	8.86	6.21	15.07	0.01	0.26	0.27	18.67	12.27	30.94	0.16	0.15	0.32	0.06	14.86	14.92
1984	8.01	-	8.01	-	-	-	12.01	-	12.01	0.08	-	0.08	0.00	-	0.00
1985	19.57	-	19.57	0.59	-	0.59	19.91	-	19.91	0.64	-	0.64	4.87	-	4.87
1986	8.41	8.58	16.98	-	2.21	2.21	10.96	15.93	26.90	0.02	0.14	0.15	0.00	13.64	13.64
1987	13.04	-	13.04	0.01	-	0.01	7.42	-	7.42	0.27	-	0.27	0.01	-	0.01
1988	21.26	-	21.26	1.06	-	1.06	17.02	-	17.02	0.53	-	0.53	1.03	-	1.03
1989	23.47	-	23.47	0.07	-	0.07	11.79	-	11.79	0.32	-	0.32	0.05	-	0.05
1990	23.43	-	23.43	0.00	-	0.00	14.84	-	14.84	0.30	-	0.30	0.40	-	0.40
1991	27.01	3.18	30.19	0.56	0.52	1.09	20.58	3.24	23.82	0.36	0.32	0.68	0.69	2.26	2.94
1992	11.93	-	11.93	0.09	-	0.09	8.07	-	8.07	0.20	-	0.20	0.00	-	0.00
1993	15.27	-	15.27	-	-	-	9.00	-	9.00	0.07	-	0.07	0.01	-	0.01
1994	15.58	6.53	22.11	0.17	0.13	0.31	10.50	5.15	15.65	0.09	0.43	0.52	0.04	2.72	2.76
1995	13.78	-	13.78	0.04	-	0.04	8.51	-	8.51	0.12	-	0.12	0.01	-	0.01
1996	15.31	-	15.31	0.10	-	0.10	6.96	-	6.96	0.07	-	0.07	0.04	-	0.04
1997	15.39	5.63	21.02	0.11	0.42	0.52	8.01	2.53	10.54	0.01	0.22	0.23	0.07	0.44	0.51
1998	14.10	-	14.10	0.09	-	0.09	7.54	-	7.54	0.05	-	0.05	0.02	-	0.02
TOTAL	293.58	37.17	330.75	3.16	3.86	7.01	279.83	55.93	335.76	8.25	2.35	10.60	33.54	53.69	87.23