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Report of the Workshop on the Status of Northern Sea Lions in Alaska

March 1987

REPORT OF THE WORKSHOP ON THE STATUS OF NORTHERN SEA LIONS IN ALASKA

Held

December 9 and 10, 1986

National Marine Mammal Laboratory

Seattle, Washington

by

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EXECUTIVE SUMMARY

The National Marine Mammal Laboratory (NMML) hosted a workshop 9-10 December 1986 to evaluate the present status and trends of northern (Steller) sea lions in Alaska and to recommend research that will identify the causes of observed declines.

There was concurrence by workshop participants that a major decline in sea lion abundance has occurred and that the decline is continuing. Analysis of life history data suggests that changes in juvenile and adult female survival rates may account for observed rates of decline; changes in fecundity may also be involved but would require large decreases in birth rates to account for observed declines. Causes for changes in survival rates were not identified but may be the result of fisheries, disease, or a combination of these and other factors. Not all results of disease research for samples collected during 1985 and 1986 were available, and will require further analysis. It was also noted that declines in northern fur seals, harbor seals, and fish-eating sea birds may have occurred in recent times in the Gulf of Alaska and Bering Sea. Changes in the composition of fish community complexes have been observed for these areas during the same time period.

Areas of important data gaps pertaining to the sea lion decline include: 1) estimates of kill by domestic fishing operations in Alaska; 2) location and time of deaths (are most deaths in winter during times of environmental stress and do these sea lions die on land or at sea?); 3) analysis of observed differences in weights and lengths of animals examined during 1977-78 and 1985-86 to determine if the observed differences are real or artifacts of sampling; 4) analysis of data collected on incidentally killed animals to determine if those animals are representative of the population and if those data can be used in future research; and 5) further analysis of samples collected during 1977-78 and 1986 to assess the contribution of disease in the decline.

Major research objectives for FY1987 and beyond were discussed and specific recommendations included:

1. Determine the combined effect of incidental and intentional mortality of northern sea lions resulting from U.S. domestic fishing activity in Alaska.

2. Continue work on assessing disease. Planning and guidance of such work should await complete analysis of samples collected in 1986.

3. Determine the time and location of mortality by placing biologists on major rookeries (e.g., Marmot Island, Alaska) throughout the year, but principally during fall and winter, to assess the nature and magnitude of deaths occurring on shore and to obtain adequate samples to determine cause of death.

4. Analyze existing data at NMML and the Alaska Department of Fish and Game (ADF&G) to determine if estimation of pregnancy rates and survival can best be obtained by long-term tagging programs, more collections, or other methods. Analysis of ADF&G data regarding animals branded during the 1970s to obtain survival rates.

5. Continue long-term research on selected rookeries to monitor abundance, distribution, reproductive parameters, and behavior.

6. Analyze cranial morphology and mitochondrial DNA, and use protein electrophoresis to assess stock identification. Because of the cost of the DNA and electrophoretic work ($20K) this topic met with limited enthusiasm and was not considered a high priority research topic, especially with available funds.

Other research briefly discussed included: Using scat collection for food habits information; more surveys to further describe distribution and abundance (participants agreed that surveys need not be more often then every third year); and a feasibility study to determine methods or drugs to restrain animals for placement of telemetry and dive recording devices.

INTRODUCTION

Aerial, ship, and land surveys of northern (Steller) sea lions (<u>Eumetopias jubatus</u>) from the central Gulf of Alaska through the central Aleutian Islands were conducted by the National Marine Mammal Laboratory (NMML), Northwest and Alaska Fisheries Center (NWAFC), and the Alaska Department of Fish and Game (ADF&G) during June-July 1984-1986. Counts from these surveys were compared to counts made in 1956-1962 and 1975-1979. Results from these comparisons indicated that the number of adult and juvenile northern sea lions on shore declined 52%, from 140,000 animals in 1956-1960 to about 68,000 animals in 1985, or an annual rate of decline of about 2.7%. Numbers have declined throughout the region, with the greatest declines in the eastern Aleutian Islands (79%) and the least in the central Aleutian Islands (8%). Significant reductions in pup numbers were also noted in the eastern Aleutian Islands and western Gulf of Alaska. The observed declines are not due to emigration since significant increases have not been noted elsewhere. However, specific cause(s) have not yet been determined despite attempts by NMML and others to identify them.

This report summarizes a workshop hosted by the NMML 9-10 December 1986 in Seattle, Washington. Objectives of the workshop were to evaluate the present status of northern sea lions in Alaska, to review results of completed research, to suggest additional research to address specific data gaps, and to recommend research that will identify the cause(s) of observed declines in numbers.

The workshop was chaired by R. DeLong, NMML; R. Merrick, NMML, served as rapporteur. A list of participants (Appendix I) and agenda (Appendix II) are attached.

BACKGROUND INFORMATION

Status of Northern Sea Lions

Alaska

After introductory remarks by H. Braham and R. DeLong, T. Loughlin presented a summary of northern sea lion biology (Loughlin et al., 1986b) and results of recent sea lion surveys in Alaska. He also included a description of the methodology for counting adults and pups, rationale for the time of day and year for optimal counts (Withrow, 1982), and estimates and recent trends of the population. Most of this information was in a draft manuscript (Merrick et al., in press) which was provided to each participant prior to the workshop. This manuscript was the basis for the conclusion that the population has continued to decline in the eastern Aleutian Islands and that significant declines are now occurring in other parts of Alaska (Table 1). Following these comments (and written comments submitted after the workshop from F. Fay) there was limited discussion with the general consensus of the participants that the Merrick et al. manuscript adequately described the status of sea lions in Alaska and that the methods used to survey sea lions were appropriate.

Ugamak Island

R. Merrick summarized research conducted on Ugamak Island (in the eastern Aleutian Islands) during 1985 and 1986. This site was used as a control to verify counts obtained from aerial surveys. The island has experienced a

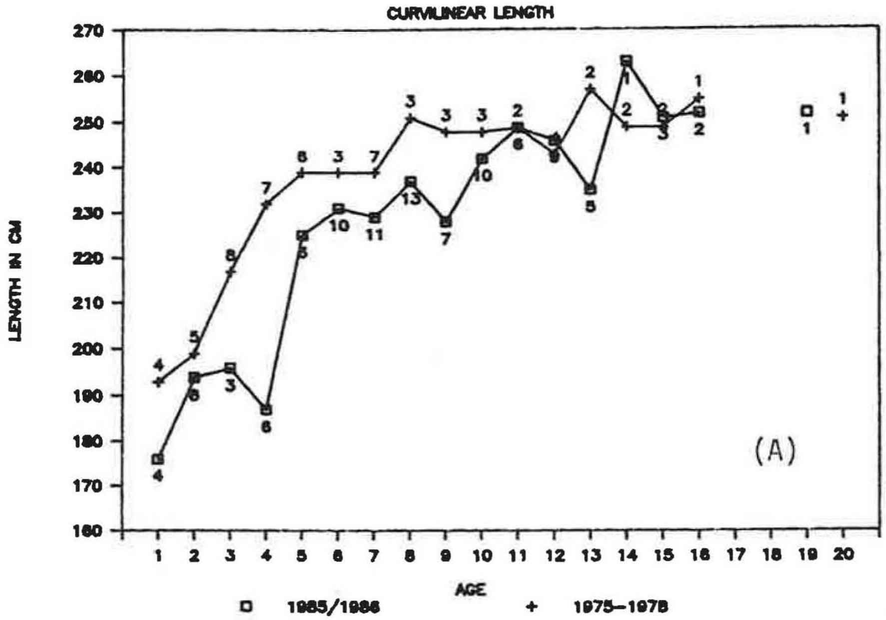
Table 1.--Counts and percent declines of adult and juvenile northern sea lions at all sites in spring and summer 1956 to 1985 in the Aleutian Islands and Gulf of Alaska (modified from Merrick et al., in press).

	Region			
Year	C. Gulf of Alaska	W. Gulf of Alaska	E. Aleutian Islands	C. Aleutian Islands
1956		24,320		
1957	35,150			
1959				28,115
1960			52,530	
1962				31,040
1975			21,221	
1976	30,677	9,480	22,142	
1977			23,922	
1979				41,677
1984			9,833	
1985	24,389	6,667	10,802	25,759
Decline				
Overall	-31%	-73%	-79%	- 8%
Annual (r)	-1.3%	-4.5%	-6.3%	-0.3%

10% annual decline since 1969 and has decreased from about 10,200 animals in 1969 to about 1,600 in 1986. Relevant data for this site are included in Merrick et al. (in press).

Gulf of Alaska

D. Calkins summarized the extensive data base obtained by the Alaska Department of Fish and Game (ADF&G) during the mid-1970s on food habits, reproduction, abundance and distribution, and other parameters for sea lions in the Gulf of Alaska (Calkins and Pitcher, 1982; Pitcher, 1981; Pitcher and Calkins, 1981). Calkins and Pitcher (1982) was distributed to all participants prior to the workshop. D. Calkins then compared the 1970s data base to information collected during 1985-1986 in the Gulf of Alaska. Probably the most significant data presented at the workshop was a preliminary analysis comparing the size of animals collected during each ADF&G study period. Sea lions collected during the 1980s were significantly smaller in length, weight, and girth than those collected during the 1970s (Fig. 1). Suggested reasons for these differences were a reduced nutritional level for young animals (0-1 year of age), disease, or a hormonal imbalance. It was recommended that these data be analyzed further to assess possible biases (such as time of year of collection, reproductive status, and water versus land collections) and confirm whether such differences exist. Comparison of food habits data were not considered significant and may be biased by timing and



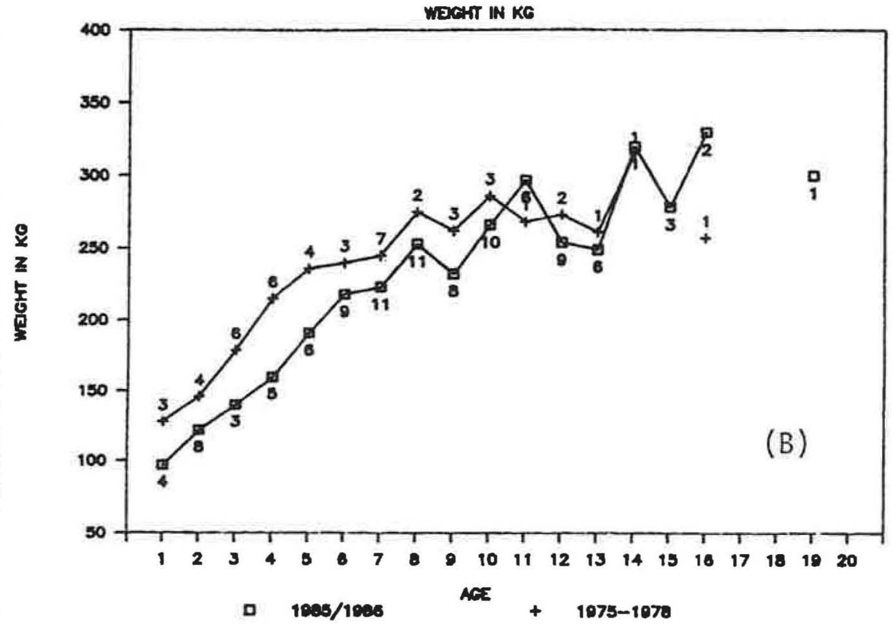
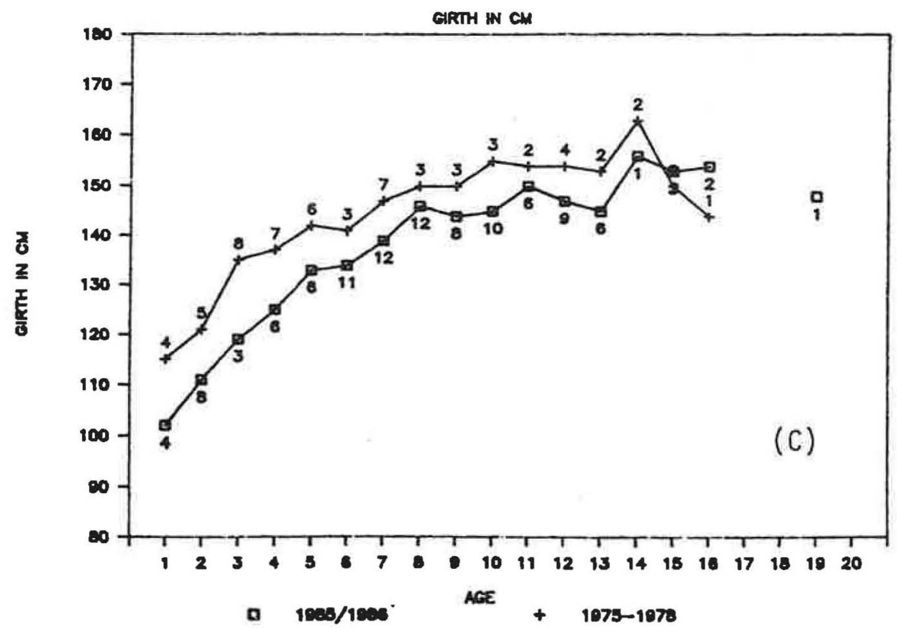


Figure 1.--Curvilinear length (A), weight (B), and girth (C) by age for northern sea lions collected near Kodiak Island, Alaska, during 1975-1978 and 1985-1986 by the Alaska Department of Game. Note the smaller size of the 1985-1986 samples compared to the 1975-1978 samples. (These data represent preliminary analysis and are subject to revision.)



location of collections (Tables 2 and 3). There was no significant difference in estimated reproductive rates between sampling years (Table 4).

British Columbia

A review of the status of northern sea lions in British Columbia was given by P. Olesiuk and was a summary of Bigg (1985). Canadian animals were reduced in number during government culling programs from 1913-1968 from about 11,000-14,000 animals to about 3,800 in 1971-1982. No recovery of Canadian sea lions has been noted since their protection in the 1970s. Concomitant to the reduction of sea lions in British Columbia, an increase in numbers occurred at Forrester Island in southeast Alaska. This increase was probably not due to animals emigrating from British Columbia during culling programs in Canada but probably due to an increased competitive advantage for sea lions at Forrester Island as Canadian animals were reduced in number. The Canadians have had good success assessing food habits by scat analysis and demonstrated that sea lions in Canada fed principally on herring and gadoids. Other workshop participants noted that elsewhere very little information has been acquired by sea lion scat analysis and that stomach content data are still the preferred source of food habits information.

Oregon

R. Brown discussed the distribution and abundance of northern sea lions in Oregon. In 1982 the maximum count for

Table 2.—All prey found in Steller sea lions in the Gulf of Alaska during 1975-78 and 1985-86. (Preliminary data from D. Calkins, ADF&G. Subject to revision).

	Frequency of Occurrence				Volume			
	1970s		1985-86		1970s		1985-86	
Prey	No.	%	No.	%	ml	%	ml	%
Gastropoda								
Snails	2	0.8	0	20	<0	<0.1	0	
Cephalopod								
Octopus sp.	20	7.7	23	25.3	250	<0.1	16,803	32.2
Gonatidae (squids)	35	13.4	2	2.2	15,507	4.2	100	0.2
Unidentified cephalopods	1	0.4	0		20	<0.1	0	
Decapoda								
Shrimps	8	3.1	0		100	<0.1	0	
Chionoecetes (tanner crab)	2	0.8	0		20	<0.1	0	
Hyas sp. (spider crab)	1	0.4	0		10	<0.1	0	
Unid. Invertebrates	1	0.4	0		10	<0.1	0	
Rajidae								
Raja sp. (skate)	1	0.4	0		960	0.3	0	
Clupeidae								
Clupea harengus (herring)	16	6.1	1	1.1	76,920	20.6	Trace	
Salmonidae								
Oncorhynchus sp. (salmon)	6	2.3	1	1.1	19,160	5.1	280	0.5
Osmeridae								
Mallotus villosus (capelin)	16	6.1	0		27,755	7.5	0	
Ammodytidae								
Ammodytes hexapterus (Pacific sand lance)	0		5	5.5	0		425	0.8
Gadidae								
Eleginus gracilis (saffron cod)	2	0.8	0		815	0.2	0	
Gadus macrocephalus (Pacific cod)	19	7.3	4	4.4	3,471	0.9	1,025	2.0
Microgadus proximus (Pacific tomcod)	1	0.4	0		680	0.2	0	
Theragra chalcogramma (walleye pollock)	102	39.1	44	48.0	217,746	58.3	23,756	46
Unident. Gadidae	2	0.8	0	--	60	<0.1	0	
Zoarcidae								
Lycodes sp. (Eelpout)	1	0.4	0		10	<0.1	0	
Scorpaenidae								
Sebastes spp. (Rockfishes)	4	1.5	0		3,030	0.8	0	
Cottidae (Sculpins)	6	2.3	1	1.1	4,960	1.3	325	0.6
Agonidae								
Agonus acipenserinus (sturgeon poacher)	1	0.4	0		60	<0.1	0	
Tricodontidae								
Trichodon trichodon (Pacific sandfish)	2	0.8	0		300	<0.1	0	
Pleuronectidae (Flatfishes)	7	2.7	7	8	1,030	0.3	7,940	15.2
Unidenetified Fishes	4	1.5	3	3.3	40	<0.1	1,516	3.0
Phocidae								
Phoca vitulina (Harbor seal)	1	0.4	0		250	<0.1	0	
Totals:	261		91		373,184		52,170	

Table 3.--Prey taken by northern sea lions by modified Index of Relative Importance for 1975-78 compared to 1985-86. (Preliminary data from D. Calkins, ADF&G. Subject to revision).

	Prey			Modified IRI			Percentage of Occurrences			Percentage of Volume		
Rank	GOA 1970s	Kodiak 1970s	Kodiak 1985-86	GOA 1970s	Kodiak 1970s	Kodiak 1985-86	GOA 1970s	Kodiak 1970s	Kodiak 1986	GOA 1970s	Kodiak 1970s	Kodiak 1985-86
1	Walleye	Capelin Pollock	Walleye Pollock	2,280	701	2,208	39.1	16.3	48.0	58.3	43.0	46
2	Herring	Walleye Pollock	Octopus	126	504	815	6.1	22.1	25.3	20.6	22.8	33.2
3	Squids	Salmon	Flatfishes	56	131	122	13.4	4.7	8	4.2	27.9	15.2
4	Capelin	Pacific Cod	Unident. Fishes	45-1	36	9.9	6.1	10.5	3	7.4	3.4	3.3
5	Salmon	Octopus	Pacific Cod	12-1	3	8.8	2.3	16.3	4.4	5.1	0.2	2
6	Pacific	Skates	Sand Lance	7	2	4.4	7.3	1.1	5.5	0.9	1.5	0.8
7	Sculpin	Flatfishes	Sculpin	3-1	2	0.66	2.3	5.8	1.1	1.3	0.3	0.6

GOA - Stomachs with contents = 153; occurrence = 261; volume = 373,184 ml.
Kodiak 1975-78 - Stomachs with contents = 49; occurrence = 86; volume = 64,551 ml.
Kodiak 1985-86 - Stomachs with contents = 68; occurrence = 91; vollume = 52,170 ml.

Table 4.--Comparisons of sexually mature female reproductive parameters for sea lions collected in the Gulf of Alaska in the 1970s and 1980s. (Preliminary data from D. Calkins, ADF&G. Subject to revision).

Months Collected	Numbers of Females		Number Pregnant		Pregnancy Rate %	
	1975-78	1985	1975-78	1985	1975-78	1985
APR - MAY	36	50	24	30	67	60
OCT - NOV	19	24	18	22	95	92

Reproductive failure rate by month: 1975-78, 4.7%;
1985, 5.4%.

Final birth rate: 1975-78, 63%;
1985, 55%.

the state was 3,000 animals; the numbers were somewhat less than that overall and the population has remained unchanged over the last 12 years. Pup mortality at rookeries in Oregon is about 10%, typical for northern sea lions. Tagging (100 pups each year) and pup branding was accomplished during 1985-1986 with resightings of tagged animals in southeast Alaska and northern California.

Soviet Union

The eighth meeting of the Marine Mammal Project, US-USSR Environmental Protection Agreement, was held 9-12 December 1986 at the NMML concurrent with the sea lion workshop. During informal gatherings and during the US-USSR meetings on December 11, information regarding the distribution and status of northern sea lions in the USSR was exchanged between NMML biologists and A. Perlov, Director, Pinniped Laboratory, TINRO. That information is summarized here since it is relevant to the workshop proceedings.

As related by A. Perlov, over 98% of sea lion pup production in the USSR is in the Kuril Islands. The status of northern sea lions on four main rookeries there is monitored regularly by fishery inspectors. The number of animals began to decline in the mid 1970s and surveys during the past 5 years indicate that the population has declined but stabilized at low levels. From 1955 to 1974 the population was estimated at 18,000-20,000 animals with 3,200-3,800 pups produced annually; the population is now estimated at 5,000-7,000 with 1,200 to 1,700 pups produced annually. There are two rookeries at Yamskiye Ostrov and one at Iony Ostrov in the Okhotsk Sea. The later has about 1,500 adults and a few hundred pups. There are about 13,000 nonbreeding sea lions in the area from the Kamchatka Peninsula to Cape Navarin during fall and winter. These animals may be immigrating from the Kuril Islands, the Commander Islands, or the Aleutian Islands after the breeding season. Pup mortality at most sites is about 12-15% or less; there are no data on juvenile or adult mortality. The April to May pregnancy rate is about 76%. In the Kuril Islands northern sea lions eat about 71.5 thousand tons of food a year, principally walleye pollock (Theragra chalcogramma), hexagrammids, squid, and octopus, the amount of each varies by location.

Status of Other Alaskan Pinnipeds

Northern fur seal (Callorhinus ursinus) populations on the Pribilof Islands have declined in recent years by more than 50% since the 1960s and the 1984 population estimate is about 871,000 animals. Pup births declined 7.5% between 1975-1981; there is no significant trend in pup production between 1981-1986. The number of territorial males is 58% below the high count in 1961 but no trend is apparent in adult male numbers. Fewer harbor seals (Phoca vitulina) were counted on the north side of the Alaska Peninsula and near Kodiak Island during surveys between 1984-85; these same areas have also experienced a decline in northern sea lions. R. DeLong discussed these trends (Table 5), noting that the data on harbor seals is preliminary and incomplete and that fur seal pup production may have stabilized in recent years.

Status of Sea Birds

V. Byrd noted that very little historical data exists on prey, survival, and abundance of fish-eating sea birds. Most of the data are unpublished and are the results of OCSEAP studies during the 1970s. He did mention two published accounts relevant to our discussions and recommended them as good overviews of fish-eating sea birds in our study area (Hunt et al., 1981; Springer et al., 1986). The status and feeding ecology of black-legged kittiwakes (Rissa tridactyla), red-legged kittiwakes (R. brevirostra), thick-billed murres (Uria lomvia), common murres (U. aalge), horned puffins (Fratercula corniculata), and tufted puffins (Lunda cirrhata) were discussed by V. Byrd.

Walleye pollock is important in the diet of sea birds at the Pribilof Islands (except horned puffins), moderately important to murres in the Gulf of Alaska and to puffins at the Semidi Islands (Table 6). Sea birds consume about 1.4×10^5 metric tons of pollock in the eastern Bering Sea. Kittiwakes normally feed on 0-1 age pollock in spring and summer, then switch to 0 age pollock exclusively in fall. Capelin (Mallotus villotus) is important to all but thick-billed murres in the Gulf of Alaska, of low importance in

Table 5.--Harbor seal trend counts at Tugidak Island and north side of the Alaska Peninsula. (From Pitcher, 1986)

Kodiak Island area - Tugidak Island (southwestern)

Year	Mean count	Standard Deviation	Range	N
1976	6,919	1961	2,800-9.300	12
1978	4,839	1288	2,532-6,817	12
1979	3,836	766	2,572-4,886	21
1982	1,575	612	660-2,323	10
1984	1,390	522	789-2,187	9

North side Alaska Peninsula Mean Counts and (Std. Dev.)

	Pt. Heiden	Seal Isl.	Pt. Moller	Cinder River
1966-1973	2,633 (N=18) (1,570)	926 (N=13) (786)	2,252 (N=16) (1,769)	1,108 (N=9) (922)
1975-1977	6,319 (N=5) (2,437)	490 (N=6) (404)	5,284 (N=6) (1,560)	2,577 (N=5) (1,401)
1985	5,603 (N=8) (687)	1,081 (N=8) (240)	3,465 (N=7) (383)	0 (N-7)

Table 6.--Relative importance of walleye pollock (WP), capelin (CA), and sand lance (SL) in the diets of selected piscivorous sea birds breeding at colonies in the western Gulf of Alaska and the south-eastern Bering Sea. (Preliminary data from V. Byrd, USF&WS. Subject to revision).

	Gulf of AK			Kodiak I.			Semidi Is.			Pribilof Is.			Cape Peirce		
	WP	CA	SL	WP	CA	SL	WP	CA	SL	WP	CA	SL	WP	CA	SL
BLKI		H	L		M	H			H	H	+	L		M	H
COMU	M	H	L							H		+		M	H
TBMU	L	L	+							H		L			
HOPU		H	L				+	+	H	L	+	L			
TUPU	+	H	H		M	H	M	+	H	H	+				

Relative importance expressed as follows: (H)igh=>35% vol.;(M)edium=20-35%; (L)ow=10-19%; +=5-9%.

BLKI = blacklegged kittiwake; COMU = common murre;
TBMU = thick-billed murre; HOPU = horned puffin;
TUPO = tufted puffin.

the Pribilof Islands, and of moderate importance elsewhere. Sand lance (Ammodytes hexapterus) is very important in the Semidi Islands and near Kodiak Island.

Black-legged kittiwakes feed near the surface within 40 km of the nest. Productivity (number of young per nest) of kittiwakes has fluctuated with some good years at Kodiak Island and the Semidi Islands since 1976, but productivity in the Bering Sea has been poor. Murres have not fluctuated in productivity nearly as much as kittiwakes, perhaps because they are divers and can find food easier at depth. However, kittiwake abundance has decreased since the 1970s. Since the 1960s, murres have declined in abundance by 50% in the northern Bering Sea and the Chukchi Sea. Nominal fishing effort occurs in the Chukchi Sea during summer when murres are present. However, murres overwinter in the southeastern Bering Sea and the decline may be attributed to disruption of the winter feeding area. There are few data available on productivity of puffins.

The causes of decline in bird abundance may be food-related since death of chicks is usually by starvation (100,000 common murres starved in 1983 on the Alaska Peninsula); chick death is usually not attributed to abandonment. There are no data on disease. Sea surface temperature influences prey availability and thus survival. Winds and storms produce a secondary effect which probably reduces feeding efficiency. Depredation by foxes, ravens, etc. is a secondary effect. Many sea birds are entangled in gill nets adjacent to the Near Islands, Aleutian Islands, but the nature and magnitude of entanglement of sea birds for the Bering Sea or Gulf of Alaska has not been determined.

Status of Fish Stocks

Biologists at the NWAFC conduct annual surveys of predetermined locations in the Bering Sea and Gulf of Alaska to assess groundfish stocks important to commercial fishing interests. Many of the groundfish species caught in commercial fishing activities and surveyed by the NWAFC are eaten by northern sea lions; the status of groundfish stocks may influence the sea lion population. R. Bakkala and M. Alton presented a review of the status and trends of groundfish stocks in the Bering Sea and Gulf of Alaska (respectively).

Bering Sea

The area of most intense study has been the eastern Bering Sea (Fig. 2). The biomass of groundfish there is 16-17 million metric tons (mmt); catches since 1970 have ranged from 1.2 to 2.2 mmt and since 1977 (when the U.S. assumed management control) from 1.2 to 1.6 mmt annually (Fig. 3). Gadids (67%) and flatfish (28%) make up most of the groundfish biomass. Walleye pollock is the most abundant fish overall constituting 50-67% of the biomass (Fig. 4) and is found from nearshore to beyond the continental shelf and from the surface to 400 fathoms. Generally, older fish are near bottom, 1- to 2- year olds

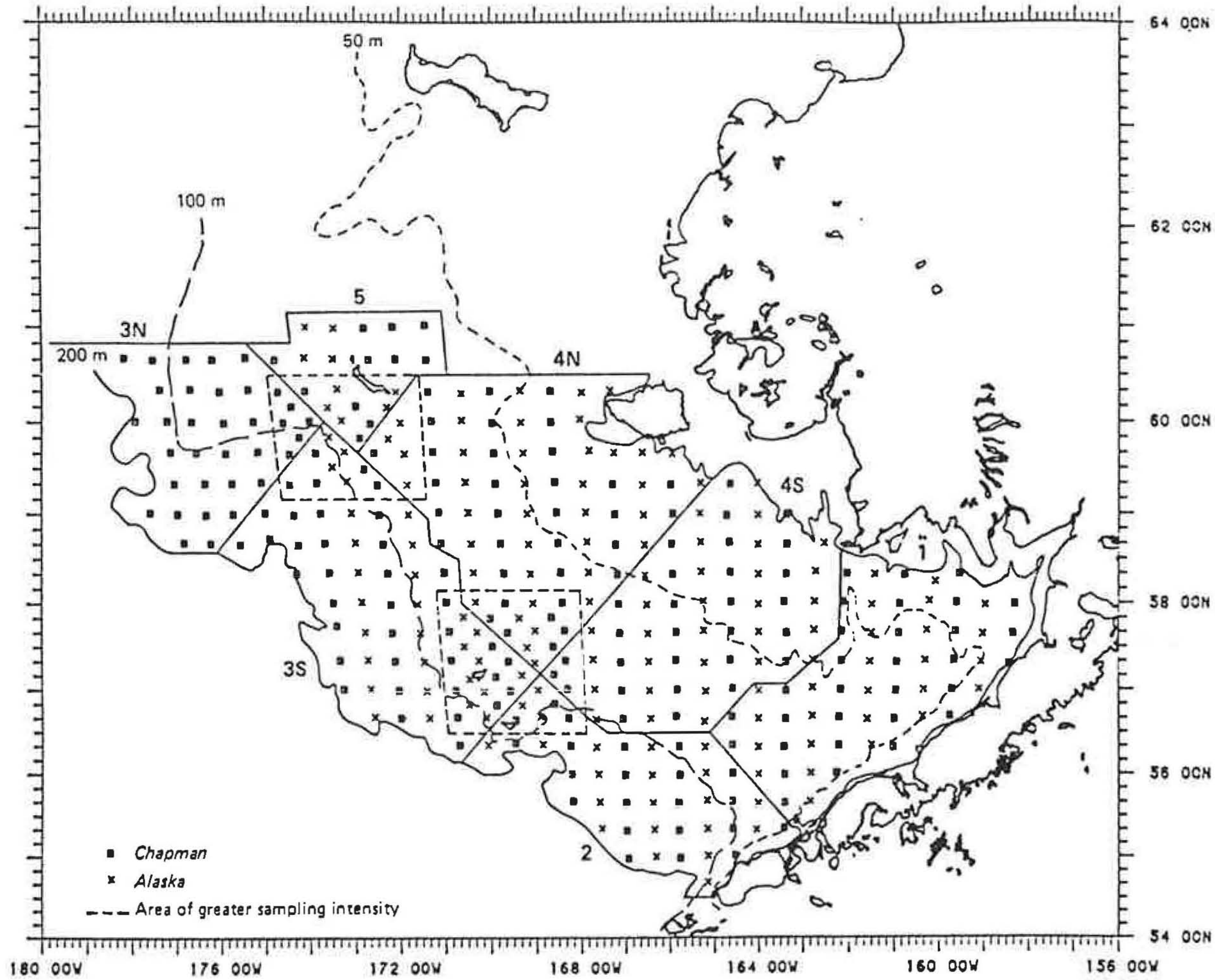


Figure 2.--Sampling stations included in the 1984 NMFS survey of the southeastern Bering Sea to assess groundfish stocks. Solid lines indicate subarea boundaries; the two regions bounded by dashed lines were sampled at high density for increased coverage of blue king crab (<u>Paralithodes platypus</u>) stocks.

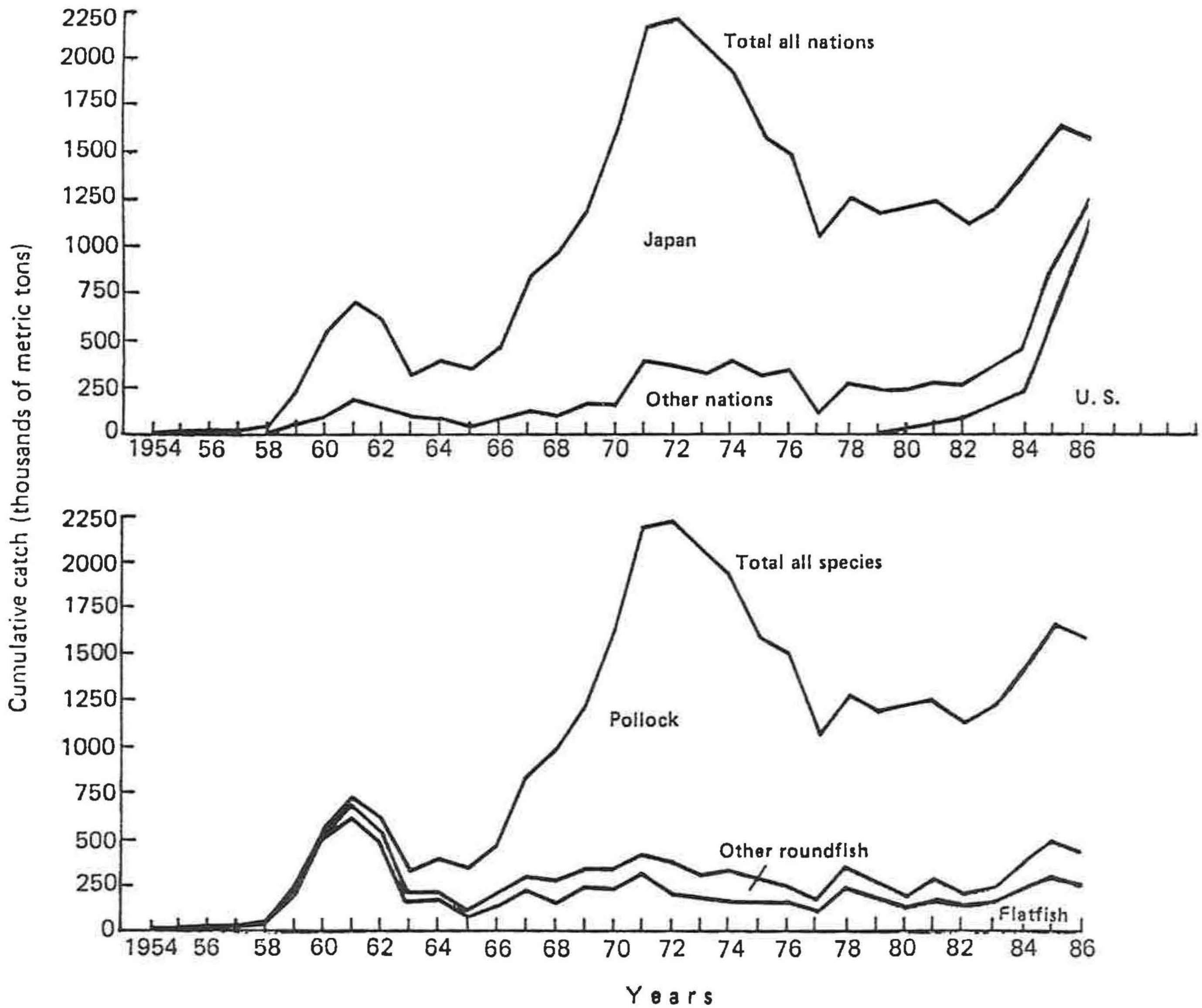


Figure 3.--Catch of groundfish in the eastern Bering Sea by nation and species group, 1954-1986.

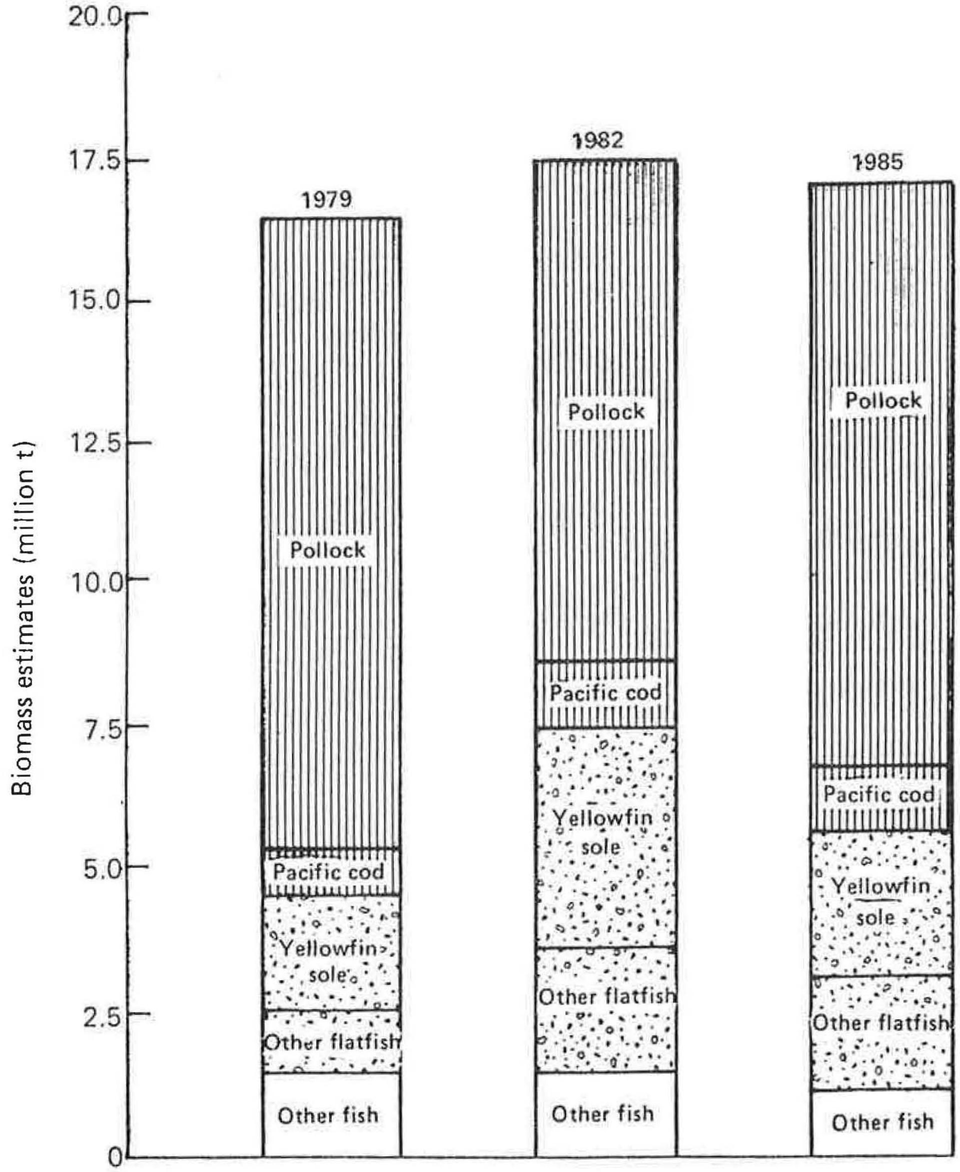


Figure 4.--Biomass estimates of total groundfish and major species in the eastern Bering Sea based on National Marine Fisheries Service comprehensive surveys in 1979, 1982, and 1985.

are higher in the water column (some age 1 and 2 year fish are always found demersally and at times they seem to be mainly demersal), and age 0 fish near the surface. Age 0 fish have been found mainly distributed over the mid-shelf or northwest of the Pribilof Islands. The 1978 year class is very robust and has been the principal year class supporting the fishery during the past 6 years; the average age of pollock has increased recently due to the strong 1978 year class and erratic recruitment for other years. The pollock stock is considered stable.

Yellowfin sole (Limanda aspera) is the second most abundant fish comprising about 2 mmt, but may be declining in abundance (Fig. 4). Pacific cod (Gadus macrocephalus) is third most abundant at about 1 mmt and has increased since 1976 due to strong recruitment of the 1977 and 1978 year classes. Pacific herring (Clupea harengus pallasi) and Pacific Ocean perch (Sebastes alutus) are in low abundance but are seasonably abundant in certain areas during spawning. There are no abundance or trend data on capelin and sand lance.

Yellowfin sole was the dominant species taken during the early commercial foreign fisheries; fishery catches reached an initial peak in 1960-1961 then declined through 1964-1965. The fishery reached a much higher peak in 1972 at 2.25 mmt as pollock became more important in the fishery (Fig. 3). Pollock represented about 80% of the catch since the early 1970s. Catches of all species declined to about

1.2 mmt in the late 1970's and early 1980's but have recently increased again to 1.6 mmt. R. Bakkala stated that the commercial catch taken from Asian waters was two to three times the total commercial catch in the Gulf of Alaska and Bering Sea.

Gulf of Alaska

Fisheries in the Gulf of Alaska during the 1960s were directed principally at Pacific ocean perch (Sebastes alutus) and Pacific halibut (Hippoglossus stenolepis); few pollock were taken until the early 1970s (Table 7). The Japanese and Soviets overfished Pacific Ocean perch and as the stock declined pollock became more important in all districts between 1961 and 1973-1975. The change in catch of pollock increased from 123 to 494 kg/standard haul near Kodiak, 37 to 417 kg/haul near Chirikof Island, and 19 to 454 kg/haul near the Shumagin Islands (Table 8).

Pollock biomass in the early 1970s was about 1 mmt; it doubled by 1981-1982, then declined due to poor recruitment (the 1982 year class was very weak but 1984 is thought to be strong). The size distribution of pollock now has but one mode (46-48 cm); formerly it was multimodal. Pacific herring was fished near the Shumagin Islands and in Prince William Sound. The catch now is five times that of the 1960s but there are no reliable biomass estimates available. Trends for other fish in the Gulf of Alaska include rock fish--decreasing through 1975 but now stable; halibut--decreasing through 1975 but now increasing; sablefish

Table 7.--Annual catch of Pacific ocean perch (Sebastes alutus) and pollock (Theragra chalcogramma) from the Gulf of Alaska, 1963-84 (in thousand t). (Preliminary data from M. Alton, NMFS. Subject to revision).

Year	Pacific Ocean Perch	Pollock
1963	136.3	7
1964	243.4	1.1
1965	348.6	2.7
1966	200.8	8.9
1967	120.0	6.3
1968	100.2	6.2
1969	72.6	17.6
1970	44.9	9.3
1971	77.5	9.5
1972	77.6	34.1
1973	56.4	36.8
1974	51.0	61.9
1975	50.4	59.5
1976	45.5	86.5
1977	21.6	120.4
1978	8.0	96.3
1979	8.1	103.2
1980	12.4	116.3
1981	12.2	149.0
1982	8.0	168.8
1983	5.4	215.6
1984	2.6	306.4

Table 8.--Comparison of catch rates between 1961 International Pacific Halibut Commission and 1973-75 NMFS research trawl surveys. Catch rates are from only those stations that were located at bottom depths between 100 and 300 m. (Preliminary data from M. Alton, NMFS. Subject to revision).

Region	Period	Number of Stations	Catch per Standard Haul (Kg) 1/	F (df)
Kodiak				
(151°-154° W. Long)	July-Sep. 1961	16	123	4.7* (1,35)
	July-Sep. 1973	21	494	
Chirikof				
(154°-159° W. Long)	June-July 1961	46	37	4.3* (1,71)
	June-July 1975	27	417	
Shumagin				
(158°-167° W. Long)	July-Aug. 1961	44	19	10.7* (1,78)
	July-Aug. 1974	36	454	

1/ For the 1961 surveys a standard tow was 1.0 hour in duration and for surveys in 1973-75 duration was 0.5 hour.

* Significant at 95% level.

(_Anoploma fimbria_)--down through 1975, then up through 1982, and now stable; Pacific cod--increasing.

Mr. Alton noted that the decline in northern sea lions occurred during a period of heavy exploitation of their prey in the Gulf of Alaska, which may have disrupted traditional patterns of prey availability. The fisheries probably took a number of sea lions directly during fishing activities.

POSSIBLE CAUSES FOR OBSERVED DECLINES

NMML scientists summarized their assessment of the possible reasons for the northern sea lion decline (Table 9). Fishery-related causes and disease were rated as having the highest potential impact. (Participants agreed with the general scheme.) Clarification was required on what "intentional take" of sea lions included and it was agreed that it should include all takes where a conscious effort to kill are involved, whether or not the take is legal. It was also noted that observed declines may not be due to any of the proposed causes but represents a natural phenomenon and that the decline is a natural cycle. No additional explanation or clarification on this issue was offered by the workshop participants.

Life Table Analysis

A. York summarized her unpublished manuscript (distributed on the first day) which analyzed life table data from Calkins and Pitcher (1982) and data from incidental mortality contained in Loughlin et al. (1983) and Loughlin and Nelson (1986). The purpose of the analysis was to detect segments of the population most sensitive to perturbation and possibly explain parts of the decline. The results of the analysis indicated that juvenile and adult (ages 3-7 years) survival were most sensitive and that changes in fecundity would require substantial changes to cause even minimal effect. Observed rates of decline could be accounted for by changing survival and fecundity in

Table 9.--Potential causes of recent northern sea lion population declines in Alaska.

Cause	Potential impact	Comment
Disease	High	Diseases causes reproductive failures, sterility, and adult or juvenile mortality
Combined impact of all fishery effects	High	Combined effect of following three causes
Changes in prey abundance or composition	Moderate	Prey (pollock) biomass decreased somewhat; abundance of target size prey low in some years
Incidental take	Moderate	Annual take probably <1000 animals
Intentional take	Moderate	Unknown amount of mortality
Commercial pup harvest	Low	May have depressed and redistributed population in 1970s. Should have little effect now
Entanglement in marine debris	Low-Adult ?-Juvenile	Low incidence of observed adult mortality; juvenile mortality unknown
Increased predation	Low	No apparent increase in predator (Killer whale) populations
Climate and ocean changes	Low	Little direct impact but may effect prey
Subsistence harvest	Low	Small annual take (<200) should effect local groups only
Pollution	Low	No apparent effect on other Bering Sea pinniped populations
Harrassment	Low	May have redistributed population but no major effect on numbers overall

different, realistic, combinations. Comparison between data from the life table generated by Calkins and Pitcher for animals collected in the 1970s to that generated by incidental catch data indicated a declining trend in survival (.878 down to .786) and mean age (7.42 down to 6.64). However, it was not clear if these data sets are comparable since the biases of each set had not been identified. Further analysis of these data were recommended by workshop participants.

Fisheries-Related Mortality

T. Loughlin summarized the data available on incidental take by foreign fisheries and the Shelikof Strait pollock joint venture fishery, and the impact of entanglement in net debris (Loughlin et al., 1983; Loughlin and Nelson, 1986; Loughlin et al., 1986a). The conclusion was, that when considered separately, the mortality of sea lions in commercial foreign fisheries and by entanglement in lost netting and debris is insufficient to account for observed declines. However, the combined take of all fisheries may constitute a large portion of observed declines. An unknown number of sea lions are killed annually by domestic fishermen in Alaska. Workshop participants stressed the importance of determining the amount of mortality in these fisheries and suggested NMML contract for studies to assess incidental and intentional mortality by domestic fishermen in Alaska.

J. Scordino discussed estimation of incidental take by analysis of annual reports of Certificates of Inclusion issued to commercial fishermen by NMFS. Of 500 permit holders in 1985, 300 submitted annual reports. Forty sea lions were reported taken (includes harassment), 37 by gunshot; but only 22 reports included kills.

One hypothesis for the reduction in the size of the northern fur seal population is the loss of fur seals entangled in net fragments and debris. C. Fowler discussed this hypothesis and noted that juvenile fur seals become entangled in fragments and debris and that by analogy so might juvenile northern sea lions. However, it was noted that the size of the head of fur seals was the determining factor (it is small in relation to typical net mesh size) and that sea lions may not become entangled as frequently because of their larger size.

R. DeLong summarized a study completed during spring and fall 1985 to determine the impact of entanglement on northern sea lions (Loughlin et al., 1986a). That study concluded that entanglement is unlikely to be a problem for adult animals but that insufficient data were available to assess the possible impact to pups and juveniles.

Disease

Disease was considered to be an important contributor to the observed sea lion population decline. Analysis of samples collected during 1985 indicated that <u>Chlamydia</u> and various caliciviruses were present in northern sea lions collected in the Gulf of Alaska (Goodwin and Calkins, 1985). Therefore, a major component of the 1986 research was to further assess the nature and magnitude of disease in the population. A more thorough and organized analysis protocol was developed which included the presence of a wildlife pathologist at all necropsies, and dissemination of tissue samples to various specialists. The presentation of results at the workshop included the report of histopathology by the wildlife pathologist (T. Spraker), results of the 1985 microbiology analysis (E. Goodwin), and present status of analysis of the 1986 samples (A. Smith).

Histopathology of 1986 samples

T. Spraker summarized data from three collection locations: 1) Forrester Island, 2) eastern Aleutians and Gulf of Alaska, and 3) Marmot Island. At Forrester Island, there was no evidence of leptospirosis or calicivirus or any other infectious degenerative, neoplastic, or toxic disease on either gross exam or histopathology. This population of northern sea lions appeared to be fairly healthy. In the eastern Aleutian Islands, two problems surfaced when compared to the Forrester Island samples: a multifocal suppurative pneumonia and hepatitis. The pneumonia was not obvious in gross exam; however, it was prevalent on histopathological examination. The etiology of the patchy lobular pneumonia appears to be associated with lungworms and bacteria. Hepatitis was found in 7 of 11 cases, and was multifocal and fairly mild. The exact cause was undetermined, but had a pattern that suggests parasitic migrations. The Marmot Island samples showed a pattern of lesions in the subadults sampled. Although clinically healthy, these animals did have lungworm and disseminated suppurative lobular pneumonia. This lobular pneumonia/lungworm complex may result in a debilitating pneumonia during "hard times" (winter) that would decrease the stamina of an animal. Calicivirus may play an important role in the pathogenesis of the lobular pneumonia. Pups examined showed an ulcerative dermatitis/myocarditis and suppurative pneumonia. Both of those conditions could be fatal to pups.

There was a general discussion as to why the disease had not run its course and how it could have been contributing to the decline over the past 20 or so years. T. Spraker speculated that it may be a cyclic phenomenon and that as new strains appear, animals not previously exposed and without appropriate antibodies are likely to be susceptible. Also, there is the possibility that more than one disease is at work on the population and that the synergistic effect of these diseases and other stress (perhaps nutritional) may result in mortalities.

Serology of 1985 samples

E. Goodwin reviewed the analysis of serum by J. Evermann which demonstrated the presence of Chlamydia antibodies in samples collected in the Gulf of Alaska during 1985. (These same animals were examined for calicivirus by

A. Smith). The implications of the presence of _Chlamydia_ in the decline are still equivocal, but it is the first such identification of the organism in pinnipeds. She also mentioned that J. Evermann had isolated, and is attempting to identify, a herpes virus from the kidney of one sample.

Serology and culture of 1986 samples

The serum samples collected in 1986 were also examined for antibodies: however, the analytical procedures were expanded from those of 1985 to assess exposure to a greater variety of organisms, plus tissue samples were collected in an effort to isolate specific organisms. A. Smith summarized the current state of analysis for each organism (_Leptospira_, _Chlamydia_, calicivirus, influenza, other viruses, and mycoplasma). The cultures for _Leptospira_ were experiencing heavy contamination, primarily fungal, and a fungistat is to be added to the transport media. Most samples are negative; two samples are still being examined as possible isolates. The serological analysis will begin in January 1987. Both culture and serological examination for _Chlamydia_ and influenza are negative, however not all samples have been analyzed. Calicivirus cultures are incomplete but to date all are negative. The serological examination has just started.

A paper by Barlough et al. (in press) discussing calicivirus in sea lions was distributed and discussed. A. Smith mentioned that caliciviruses have been around a long time and that they may have a cytolytic and noncytolytic component which is temperature dependent. In fish the noncytolytic phase may be dominant, then once in a warm mammal, the cytolytic phase is triggered with its pathogenic effect.

R. DeLong summarized this section by stating that calicivirus and Chlamydia are probably important and are linked to histopathology. A. Smith added that even though influenza has not yet been identified, it should not be ruled out. During discussions and in follow-up written comments, A. Sparks and F. Morado were skeptical as to the importance of disease as a factor in the present decline, and suggested additional analysis and modifications to the protocol to improve the resolution of future disease investigations.

FUTURE RESEARCH

A number of topics for future research were discussed by the participants and are summarized here.

Estimate Mortality Resulting From Domestic Fishing

Hypothesis

The combined incidental and intentional mortality of northern sea lions resulting from U.S. domestic fishing activity is sufficient, when added to deaths resulting from foreign fishing, to account for observed declines.

Rationale

To date there is no reliable estimate of the number of sea lions incidentally or intentionally killed by domestic fishing activity in Alaska. The number of sea lions killed in foreign fishing is insufficient to account for observed declines, but, depending on the magnitude of the kill in domestic fisheries, the combined take of all fisheries may be responsible for most of the observed declines. The NMML proposed to assess the nature and magnitude of domestic kills of northern sea lions in Alaska from Prince William Sound (or perhaps southeast Alaska) to the western Gulf of Alaska (Sand Point area).

Participants agreed that information from the domestic fishery was important to assess the relative impact of fisheries on the decline of northern sea lions in Alaska. This topic is becoming more important as fewer foreign vessels and more domestic vessels fish within the Exclusive Economic Zone (EEZ) in Alaska. Participants did not believe that a domestic observer program would supply the needed information or is feasible. The space limitations on most domestic fishing vessels would probably preclude placement of an observer. Also, data on intentional kill would not be gained by observer placement since any illegal intentional kill would not occur while the observer was aboard. The legal ramifications of observer placement were also discussed. It was generally agreed that it would be most profitable to first assess the type of fisheries involved and locations of most incidental and intentional take problems, then follow by more intensive studies. Dockside interviews, analysis of fishing association logbooks, and other unnamed sources would likely provide the most useful information. The workshop participants agreed that this work should be contracted to an independent research organization outside the NWAFC.

Disease

There was discussion regarding the adequacy of the 1985-86 disease work, progress to date, and the type of research to be completed during 1987 and beyond. However, because analysis of the 1986 samples was not complete, discussion of plans for future work was limited. One study that was discussed involved the relation of *Chlamydia* to abortion and it was suggested that a field party visit an appropriate collection site (such as Cape St. Elias) in mid-March to collect premature and aborted pups and their mothers. Tissues would be analyzed for presence of

<u>Chlamydia</u> and other relevant disease organisms. The NMML will discuss other future disease work with those knowledgeable in the field once all information from the present studies are available.

Estimate On-Land Mortality: Marmot Island

Hypothesis

The principal time of year to observe dead or dying northern sea lions is late fall and winter during times of extreme environmental conditions.

Rationale

Land studies during spring, summer, and early fall have failed to document sufficient numbers of dead or dying sea lions to account for observed declines. Environmental perturbations, such as storms, temperature fluctuations, and extreme tidal levels during late fall and winter may impose additional stress to sick or moribund animals resulting in death. The NMML proposed to place biologists on Marmot Island during the reproductive season and from October through March to record the number of dead or dying sea lions observed on beaches and to take samples necessary to determine sex, age, and cause of death. Negative results (no dead or dying animals observed) would imply that most mortality occurs at sea.

Participants were in general agreement with the need for this study but some suggested that surveys could be completed from Kodiak Island and thus reduce the costs of placing observers on the island for long periods. It was also noted that females and pups should be marked during summer to determine survival and movements of individual animals.

Methods for Assessing Juvenile Mortality Rates and Adult Female Mortality and Pregnancy Rates

Hypothesis

Estimates of mortality and pregnancy rates can be made from life table data based on collections of animals from the declining population or from long-term resightings or recoveries of tags applied to pups.

Rationale

The northern sea lion decline may be due to increased mortality of adult females or juveniles, or both, or a decline in pregnancy rates. In a declining population there are problems in applying either of the above methods (collections or tagging) to estimate the desired population parameters. The removal of large samples of animals from the population may exacerbate the decline, and due to high juvenile mortality, large numbers of pups must be tagged in order to have adequate numbers of females surviving to the age of recruitment and early reproductive years. In addition, available tags do not have adequate longevity to provide marks over the reproductive life of the female.

The NMML proposed a study to evaluate whether long-term tagging studies or sampling animals from the population would provide the best estimates of population parameters with acceptable minimal impacts on the population.

Consideration would be given to the number of tags which would have to be applied to pups each year to allow estimation of survival values of juvenile mortality. Sample size calculations will be made to determine the number of animals which would have to be collected to generate estimates of survival and pregnancy rates.

Participants agreed to the need for this study. They also suggested analysis of existing data at the NMML and ADF&G, particularly those data regarding animals branded during the 1970s by the ADF&G, to determine pregnancy rates and survival.

Surveys

NMML biologists proposed that surveys to assess distribution and abundance were not needed during FY 1987. However, long-term research on abundance, distribution, reproduction, and general behavior at key rookeries, such as Ugamak Island or Marmot Island, should continue. It was generally agreed by all participants that surveys of the type completed in 1985 need not occur until 1988 or about every third year. Even then, it may be more efficient and cost effective to select specific control sites as counting areas, rather than surveying most of the Alaskan range every third year.

Stock Identification

Hypothesis

Northern sea lions that breed in the eastern Aleutian Islands exhibit different morphological, genetic, and biochemical characteristics from those that breed in the eastern Gulf of Alaska or other parts of the species range.

Rationale

At present there are insufficient data to determine if northern sea lions in the Aleutian Islands are of a different subspecies or stock from sea lions in the Gulf of Alaska or other parts of their range. Determination of stock discreteness will be important to U.S. biologists that are requested to recommend various geographic locations or populations for management purposes. The proposed study would be a mitochondrial DNA analysis and electrophoretic analysis of blood and tissue proteins of sea lions collected at rookeries from Oregon to the eastern Aleutian Islands. The work could be conducted by F. Utter and his associates at the NWAFC. NMML biologists will also conduct a study of meristic and nonmeristic cranial characters to determine stock discreteness.

Because of the high cost of the DNA and electrophoretic studies (estimated at $20K) this topic met with limited enthusiasm and was not considered high priority research, especially with limited funds. Participants agreed that the North Pacific Fishery Management Council be requested to fund this work since it would aid management of fisheries in relation to sea lion distribution.

Other Studies

Due to time limitations, other studies such as additional food habits studies and replacement of stomach content data with scat collection data received limited attention. However, during the course of the workshop it was generally accepted that food habits data collected by the ADF&G during the 1970s and 1985-86 were adequate and further collections were not required until the late 1980s or early 1990s. Analysis of scat collections may provide some insight into the changes of diet through time but would probably not improve on the current data base regarding proportion of species consumed.

NMML biologists briefly mentioned the need to conduct a feasibility study to determine methods or drugs to restrain animals for placement of telemetry and dive recording devices. The intent of this subject was favorably received informally, but was not discussed during the workshop meeting.

LITERATURE CITED

Barlough, J. E., E. S. Berry, E. A. Goodwin, R. F. Brown, R. L. DeLong, and A. W. Smith. In press. Antibodies to marine caliciviruses in the Steller sea lion (Eumetopias jubatus Schreber). J. Wildl. Dis. 23.

Bigg, M. A. 1985. Status of the Steller sea lion (Eumetopias jubatus) and California sea lion (Zalophus californianus) in British Columbia. Can. Spec. Publ. Fish. Aquat. Sci. 77; 20 p.

Calkins, D. C., and K. W. Pitcher. 1982. Population assessment, ecology and trophic relationships of Steller sea lions in the Gulf of Alaska. Alaska Dept. Fish and Game, Final Rep. RU243. 128 p. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99502.

Goodwin, E. A., and D. G. Calkins. 1985. Preliminary results of ongoing investigations of San Miguel sea lion virus, leptospirosis, and chlamydiosis in Alaska Steller sea lions and their relationship to declining pup counts. Presented at the Sixth Bienn. Conf. Bio. Mar. Mammals, Vancouver, B.C. Nov. 1985. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99502.

Hunt, G. L., Jr., B. Burgeson, and G. A. Sanger. 1981. Feeding ecology of seabirds of the eastern Bering Sea. In, D. W. Hood, and J. A. Calder (editors), The eastern Bering Sea shelf: oceanography and resources, Vol. 2. Office of Marine Pollution Assessment, Juneau, Alaska, p. 629-648.

Loughlin, T. R., L. Consiglieri, R. L. DeLong, and A. T. Actor. 1983. Incidental catch of marine mammals by foreign fishing vessels, 1978-81. U.S. Natl. Mar. Fish. Serv., Mar. Fish. Rev. 45 (7-8-9):44-49.

Loughlin, T. R., P. J. Gearin, R. L. DeLong, and R. L. Merrick. 1986a. Assessment of net entanglement on northern sea lions in the Aleutian Islands, 25 June-15 July 1985. Nat. Mar. Fish. Serv., NWAFC Processed Report 86-02. 50 pp.

Loughlin, T. R., M. A. Perez, and R. L. Merrick. 1986b. Eumetopias jubatus. Mammalian Species Account 283. Amer. Soc. Mamm. 7 pp.

Loughlin, T. R., and R. Nelson, Jr. 1986. Incidental mortality of northern sea lions in Shelikof Strait, Alaska. Mar. Mammal Sci. 2:14-33.

Merrick, R. L., T. R. Loughlin, and D. G. Calkins. In press. Decline in abundance of the northern sea lion (Eumetopias jubatus) in Alaska, 1956-86. Fish. Bull., U.S.

Pitcher, K. W. 1981. Prey of the Steller sea lion, Eumetopias jubatus, in the Gulf of Alaska. Fish. Bull., U.S. 79:467-472.

Pitcher, K. W. 1986. Harbor seal trend count surveys in southern Alaska: 1984. Unpubl. manuscr., 10 p.

Alaska Dep. Fish and Game, 333 Raspberry Road, Anchorage, Alaska, 99502.

Pitcher, K. W., and D. G. Calkins. 1981. Reproductive biology of Steller sea lions in the Gulf of Alaska. J. Mammal., 62:599-605.

Springer, A. M., D. G. Roseneau, D. S. Lloyd, C. P. McRoy, and E. C. Murphy. 1986. Seabird responses to fluctuating prey availability in the eastern Bering Sea. Mar. Ecol. Prog. Ser. 32:1-12.

Withrow, D. E. 1982. Using aerial surveys, ground truth methodology, and haul out behavior to census Steller sea lions, Eumetopias jubatus. Unpubl. M.S. Thesis, Univ. Washington, Seattle. 102 pp.

York, A. E. 1986. Comments on the life table for female Steller sea lions. Unpubl. manuscr., 28 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service NOAA, 7600 Sand Point Way NE, Seattle, WA 98115.

APPENDIX I

NORTHERN SEA LION WORKSHOP 9-10 DECEMBER 1986

NATIONAL MARINE MAMMAL LABORATORY, SEATTLE, WASHINGTON

LIST OF PARTICIPANTS

National Marine Fisheries Service
- NMML- Dr. Howard Braham, Dr. Robert DeLong, Dr. Thomas Loughlin, Dr. Charles Fowler, Richard Merrick Anne York, Michael Perez, George Antonelis, Jr., David Withrow
- RACE- Richard Bakkala, Miles Alton, Dr. Al Sparks, Dr. Frank Morado
- Southwest Fisheries Center- Dr. Rennie Holt
- Alaska Region- Dr. Steve Zimmerman
- Northwest Region- Joe Scordino
- Washington, D.C.- Ben Drucker, Dr. Charles Karnella

Alaska Department of Game- Donald Calkins, Enid Goodwin

University of Alaska- Dr. Francis (Bud) Fay

Marine Mammal Commission- Dr. Murray Johnson

Alaska Maritime National Refuge- G. Vernon Byrd

Washington State University- Dr. James Evermann (unable to attend)

Oregon State University- Dr. Al Smith

Colorado State University- Dr. Terry Spraker

Oregon Department of Game- Robin Brown

Canadian Department of Fisheries and Oceans- Peter Olesiuk

APPENDIX II

NORTHERN SEA LION WORKSHOP 9-10 DECEMBER 1986

NATIONAL MARINE MAMMAL LABORATORY, SEATTLE, WA

AGENDA

Day 1

900-915	Welcome- Braham
915-930	Why the workshop and expected results- DeLong
930-1015	Review of present status of nsl, general overview of recent surveys, and comparison of survey methods- Loughlin, Brown
1015-1030	Break
1030-1050	Ugamak studies- Merrick
1050-1150	Summary of pre-1985 studies and results of post-1985 studies (excluding disease)- Calkins
1150-1200	Possible causes for the decline-Loughlin
1200-1300	Lunch
1300-1340	Incidental and intentional take, entanglement- Loughlin, Calkins, and Fowler, (Zimmerman and Scordino)
1340-1410	Disease- Histopathology of 1986 samples- Spraker
1410-1440	*Chlamydia* and *Leptospira*- Goodwin, Evermann
1440-1510	SMSV, influenza, etc.-Smith
1510-1530	Break
1530-1700	More disease; Relation of infectious process and agents to pathology observed in 1986; questions and review

Day 2

900-925	Soviet scientist review; questions about yesterday or other business
	Life table analysis- York
925-945	Fur seals and harbor seals in Alaska- DeLong, Calkins
945-1025	Fishery resources in Bering Sea and GOA- Bakkala, Alton
1025-1045	Break
1045-1115	Marine birds- Byrd
1115-1130	Questions from previous topics
1130-1200	What next? DeLong
	1. More disease work- where, when, what age and sex groups; which pathogens
1200-1300	Lunch
1300-1650	What next? (cont.)- DeLong
1300-1320	2. New repro. rate and survival/population structure studies
1320-1405	3. More surveys-where and when
1405-1420	4. Ugamak, Marmot, or Sugarloaf
1420-1430	5. Stock identification studies
1430-1445	6. Domestic kill studies
1445-1500	7. Feeding habits-prey availability
1500-1515	Break
1515-1600	8. Other studies to be identified
1600-1650	9. Priority of future studies
1650-1700	Ending Remarks- Braham