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AERIAL AND SHIP-BASED SURVEYS OF NORTHERN SEA LIONS (EUMETOPIAS JUBATUS) IN THE GULF OF ALASKA AND ALEUTIAN ISLANDS DURING JUNE AND JULY 1990

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ABSTRACT

Aerial and ship-based surveys of northern sea lions (Eumetopias jubatus) conducted during June and July 1990 from the Kenai Peninsula to Kiska Island in the Aleutian Islands, reconfirm findings of the 1989 survey that the area's population has declined significantly since 1956. Declines occurred at all regions and sites during the 1956-89 period. The total number of sea lions counted in the Kenai to Kiska study area, however, did not change significantly either in the study area or in any region between 1989 and 1990. Adults and juveniles counted at 77 trend sites decreased from 105,289 in 1956-59 to 55,824 in 1985 and then to 23,064 and 22,754 in 1989 and l990, respectively. Between 1989 and 1990 the counts of adults and juveniles increased in the eastern Aleutian Islands (from 3,032 to 3,801) and central Aleutian Islands (from 7,572 to 7,988). The total count of sea lions in the western Gulf of Alaska remained essentially unchanged from 3,908 in 1989 to 3,915 in 1990. Sea lion numbers decreased in the central Gulf of Alaska between 1989 and 1990, from 8,552 in 1989 to 7,050 in 1990. Numbers of live pups counted at 19 major rookeries located from Chirikof Island to Kiska Island decreased between 1985 (21,391) and 1990 (6,871). However, at the only three rookeries counted in 1989, pup numbers increased by 29% between 1989 and 1990 at Bogoslof and Seguam Islands, while decreasing by 25% at Kiska Island.

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INTRODUCTION

In the 1989 aerial survey of adult and juvenile northern sea lions (Eumetopias jubatus) from the Kenai Peninsula to Kiska Island, Alaska 24,953 animals were found hauled out at 87 sites., This represented a decline of 63% from the 67,617 animals recorded for the same area in 1985. Declines were most apparent in the eastern Aleutian Islands, where northern sea lion numbers decreased 71% from 10,802 animals counted in 1985 to 3,145 in 1989 (Loughlin et al. 1990). These data supported the observations of population declines recorded previously by Braham et al. (1980) and Merrick et al. (1987). Equally alarming was the expansion and intensification of the decline in abundance eastward through the central Gulf of Alaska (to at least Outer Island) and westward throughout the central Aleutian Islands. The greatest decline in abundance at any one rookery was found at Seguam Island, (central Aleutian Is-lands) where observed sea lion numbers decreased by 80% from 2,942 animals in 1985 to 602 animals in 1989 (Loughlin et al. 1990). The number of pups counted at Bogoslof, Seguam, and Kiska Islands decreased by 77% during the 1985-89 period.

The speed and intensity of these declines led to an emergency listing on 5 April 1990 of the northern sea lion throughout its range as "threatened" under the Endangered Species Act (55 Fed. Reg. 12645). This was an interim measure designed to provide immediate protection to the species and also to allow

public comments and additional scientific evidence to be gathered about the status of the species prior to the final ruling. The final ruling of the species as "threatened" was published in 26 November 1990.

This report summarizes the most recent northern sea lion survey information--results of 1990 aerial and ship-based surveys in Alaska. Counts were made of adult and juvenile northern sea lions at rookeries and haul-out sites from the Kenai Peninsula to Kiska Island in the central Aleutian Islands, and also of pups at rookeries from Chirikof Island in the central Gulf of Alaska to Kiska Island. These 1990 surveys repeat the National Marine Mammal Laboratory (NMML) 1985 and 1989 surveys (Loughlin et al. 1986; Merrick et al. 1987; Loughlin et al. 1990; Merrick et al. 1990).

METHODS

Protocols for the 1990 surveys followed the rationales and methods of earlier aerial and ship supported on-land surveys (Braham et al. 1980; Calkins and Pitcher 1982; Withrow 1982; Loughlin et al. 1986; Merrick et al. 1987; Loughlin et al. 1990). Counts of adults and juveniles presented here are for one day. The surveys do not account for any daily variation due to weather, disturbance, and other factors. The observations also do not include animals at sea. Consequently, the counts of nonpups presented here should be treated as indices of abundance for analysis of population trends rather than absolute estimates

of abundance. Because the surveys being compared have been conducted at the same time of day and year, it is unlikely that daily variation is sufficiently different between years to account for the observed declines in abundance (Withrow 1982; Merrick et al. 1987). The major advantage of this method is that it continues a time series of counts extending back to 1956 (Merrick et al. 1987).

On-land pup counts obtained before pups enter the water or leave the island provide a-more reliable index of population trends than aerial surveys (Berkson and DeMaster 1985). However, these on-land surveys are difficult and costly to perform, disturb the rookery, and are only available for a few sites and for a limited period of time (ca. 1976 to the present). Thus, neither technique is entirely satisfactory. The combination of the two techniques, however, provides the best approach available for monitoring population trends of northern sea lions in Alaska.

Adult and juvenile northern sea lions were counted and photographed from airplanes overflying rookeries and haul-out locations from Outer Island (Kenai Peninsula) to Amchitka Island (central Aleutian Islands) during 11-23 June 1990 (Fig. 1). The initial intent to survey as far west as Kiska Island was thwarted by bad weather. Sites missed during the aerial survey were visited during the boat survey, and counts were made then of adults and juveniles. While flights were designed to visit traditional sea lion rookeries and haul-out areas (Loughlin ,et al. 1984), potential haul-out sites along the flight path were

examined enroute to the primary sites. Under ideal conditions flights were conducted at approximately 200 m altitude, air speed at 90-100 knots, and approximately 500 m offshore. Strong winds required flights to be higher and farther offshore, while fog required flights to be somewhat lower. A Grumann Widgeon' airplane was used for surveys between Outer Island and the Semidi Islands; a Piper Navajo airplane was used for flights to the areas west of the Semidi Islands. Initial counts of animals were visually estimated and immediately recorded on plastic covered charts of the area. Animals were simultaneously photographed using a 35 mm auto-focus camera with a motor drive and 70-210 mm zoom lens. Photographs were usually not taken if there were less than 100 animals on the site. Later in the laboratory, the processed slides were projected onto a white background and the animals counted. The arithmetic mean of three independent counts was used as the final estimate for each site.

Pup counts were obtained between 25 June and 21 July at most rookeries from Chirikof Island (central Gulf of Alaska) to Kiska Island (central Aleutian Islands). A charter fishing vessel (Big Valley) delivered the survey team to within 2-4 km of a site, and the survey team then went ashore using a small inflatable boat. Pups were counted by first clearing the rookery of all sea lions other than pups. After these adults and juvenile animals retreated to the water, three persons acting as counters made

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'Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

independent counts of the live pups on the beach and in the water. The final count for a site represents the arithmetic mean of the three counts.

Entangled animals, dead adults, and other marine mammals were recorded when seen.

To determine trends in relative abundance we analyzed only sites counted in all surveys. While we surveyed 152 sites during 1990, only 77 had been surveyed in all previous surveys back to 1956. We defined these 77 sites as "trend sites" (Table 1). Most of the remaining 75 were small haul-out sites. The only significant exceptions were the Outer Island, Column Rocks, and Semisopochnoi Island rookeries. Between-year comparisons were made between trend sites and their respective regions (Fig. 1) by several methods. Instantaneous rates of change between two years were calculated for regions as follows:

$$N_t = N_o d^t$$

where:

N_t = count in year t (1990)

N_0 = count in base year (e.g., 1956)

t = number of years between base year and year t, and

d = rate of change, with the percent annual change calculated as (d-l) x 100.

Correlation coefficients (r) were used to evaluate whether temporal trends were significant. Finally, a Wilcoxon two-sample signed rank test (W statistic; Hollander and Wolfe 1973) was used for comparisons of 1989-90 changes at rookeries within a region.

RESULTS

Sea Lion Surveys

A total of 22,754 adult and juvenile sea lions were counted in 1990 at the 77 trend sites (Table 2). This represents a statistically significant decline of 78% ($r = -0.915$, $P < 0.05$) from the 105,289 animals counted at the 77 sites in 1956-59 (5% decrease per year: Fig. 2; Table 2). The decrease from the 55,824 animals counted in 1985 to the 1990 count represents a 59% decline (16% per year decrease). However, between 1989 and 1990 numbers declined only 1% (from 23,064 to 22,754).

Considering only the trend site observations, we found 7,050 sea lions (31% of the total) in the central Gulf of Alaska, 3,915 (17%) in the western Gulf of Alaska, 3,801 (17%) in the eastern Aleutian Islands, and 7,988 (35%) in the central Aleutian Islands. Each of these regional changes represents a large decline from the counts made in the 1956 to 1959 period (Table 2, Fig. 3), and all regional counts other than those in the central Aleutian Islands are significantly lower (P c 0.05). The greatest declines occurred in the eastern Aleutian Islands (-90% overall, 7% per year), and the least in the central Aleutian Islands (-53% overall, 2% per year). Particularly large declines occurred during the 1985-90 period (Table 2) with annual rates of decline ranging from 9% in the western Gulf of Alaska to 19% in the central Aleutian Islands. These regional declines, however, moderated in the past year as only the central Gulf of Alaska showed any decrease (18%) from 8,552 animals in 1989 to 7,050 in

1990. Western Gulf of Alaska and central Aleutian Island numbers have shown little change in the past year, while eastern Aleutian Island numbers increased from 3,032 to 3,801 animals (+25%; Table 2).

The extent of the declines in adult numbers is also apparent from the number of nonpups observed on rookeries (mostly breeding males and females). Twenty-five of the 27 rookeries in the study area (excluding Outer and Amchitka Islands) were used in trend analysis (Tables 3 and 4). The number of animals counted at the 25 rookeries declined significantly ($r = -0.910$, $P = 0.05$) from 79,982 (-77%) in 1956-59 to 18,694 in 1990 (Table 3). Significant declines ($P < 0.05$) were observed in all regions other than the central Aleutian Islands, with the largest declines occurring in the eastern Aleutian Islands (-90%). Rates of decline intensified after 1985, reaching -16% per year in the central Gulf of Alaska and -15% in the central Aleutian Islands through 1989. Between 1989 and 1990 there was no further decline in sea lion numbers in the study area as a whole. Of the four regions, only the central Gulf of Alaska's rookery populations decreased (-19%) between 1989 and 1990 (from 6,207 to 5,043 animals: Table 3). Two of the other three regions showed increases--21% in the eastern Aleutian Islands (from 2,813 to 3,417 animals) and 10% in the central Aleutian Islands (from 6,106 to 6,738 animals). The fourth region, the western Gulf of Alaska, showed no change between 1989 and 1990 (from 3,521 to 3,496). None of the regional changes from 1989 to 1990 were

statistically significant ($P > 0.5$; Table 3).

Loughlin et al. (1990) reports that sea lion numbers at all rookeries in the study area (except Chernabura Island) declined between 1985 and 1989 (Table 4). However, between 1989 and 1990, numbers increased at 12 of the 25 rookeries (Table 4). Large decreases were still observed at some sites, particularly in the area from the Barren Islands (e.g., 29% at Sugarloaf Island) to the Shumagin Islands (e.g., 19% at Chernabura Island). These decreases were balanced by large increases at rookeries in the Aleutian Islands (e.g., 110% at Ugamak Island, 108% at Agligadak Island).

We found no increases at haul-out sites which could balance the rookery decreases. In fact, most haul-out sites showed greater decreases than rookeries. Haul-out sites accounted for 18% of the animals surveyed during 1990, as compared with 24 and 30% in 1956-59 and 1985, respectively.

We counted 7,252 pups at 22 rookeries (Table 1). Pup numbers decreased 68% (from 21,391 to 6,871) at the 19 rookeries counted in both 1985 and 1990 (Table 5). Large declines occurred during the 5-year period at all sites other than Chernabura and Akun Islands. Pupping no longer occurs at Agligadak Island. The largest decreases in pup numbers since 1985 were observed in the central (-81%, from 5,120 to 951) and western (-72%, from 2,293 to 633) Gulf of Alaska. Large decreases also occurred at some sites in the Aleutian Islands (e.g., Yunaska Island).

A complete pup survey of the area was not conducted between

1985 and 1990; however, pup counts were made at three sites in the Aleutian Islands during 1989--Bogoslof, Seguam, and Kiska Islands (Merrick et al. 1990). Between 1989 and 1990, pup numbers increased at Bogoslof and Seguam Islands by 29%, while decreasing by 25% at Kiska Island (Table 5). U.S. Fish and Wildlife Service biologists surveyed part of Ugamak Island during 1989 and found 434 pups there (Byrd 1989): our 1990 survey of the same area found 419 pups.

Other Observations

Three dead adult northern sea lions were observed--one each at Bogoslof (male), Adugak (female), and Yunaska (female) Islands. The dead animal at Adugak Island appeared to have been shot in the head: cause of death for the others is not known.

Five entangled sea lions and one entangled northern fur seal (Callorhinus ursinus) were observed. All entangled animals appeared healthy.

We counted 618 harbor seals (Phoca vitulina) at 23 sites in the study area (Table 6). This represents a minimum estimate of their numbers because surveys were not scheduled at low tides. In addition, aerial surveys are a poor method for surveying harbor seals in the Aleutian Islands because most of these cryptically colored animals haul out on similarly colored rocks.

Northern fur seals were observed at Chowiet (1 adult male), Adugak (1 adult male), and Bogoslof (>600 subadult males) Islands. Fur seals at Bogoslof Island have now occupied the entire northern end of the island, and have expanded their

hauling out areas to include parts of the upper berm on the southern end of the island.

DISCUSSION

Results from our 1990 survey confirm the observations of Loughlin et al. (1990) that a major decline in northern sea lion numbers has occurred since 1985 (Merrick et al. 1987) but 1989 and 1990 numbers appear to be the same. This may mask true regional differences in population trends. While sea lion numbers counted at rookeries and haul-outs remained unchanged between 1989 and 1990 in the central Aleutian Islands and the western Gulf of Alaska, numbers may have increased in the eastern Gulf of Alaska (25%). On the other hand, between 1989 and 1990 sea lion numbers may have decreased in the central Gulf of Alaska at the same rate as experienced during 1985-89 (-18% per year). The lack of statistically significant differences between 1989 and 1990 in the eastern Aleutian Islands and central Gulf of Alaska may be due as much to the small sample sizes and weakness in the power of the Wilcoxon test, as to a true lack of change in population abundance.

Increases observed at some sites in the Gulf of Alaska and Aleutian Islands may be real or may simply be an artifact of a better series of photos taken in 1990, which would have resulted in higher counts. For example, the 1989 Outer Island NMML aerial survey count was 350 animals but the photographs were difficult to read because of fog. An aerial survey conducted by the Alaska

Department of Fish and Game (NMML files) a few weeks later in better weather recorded 1,127 animals there. Similarly poor conditions for photography occurred in the eastern Aleutian Islands during 1989 but not in 1990.

Declines in pup abundance support the hypothesis that large numerical declines occurred during 1985-90. Increases or lack of change in pup numbers observed at Bogoslof, Seguam, and Ugamak Islands from 1989 to 1990 indicate the population decline may be moderating in the Aleutian Islands.

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Table 1. --Counts of northern sea lions at rookeries (*) and haul-out locations in the Gulf of Alaska and Aleutian Islands during June and July 1990. A (+) indicates a site used for trend count analysis.

Location	Adult and juvenile				PUP	
	Date	Time	Type[a]	Count	Date	Count
Central Gulf of Alaska						
Puale Bay	6/12	0910	P	387		
Takli	6/12	0940	V	0		
Cape Gull	6/12	0950	V	0		
Shakun Rocks	6/12	1007	P	140		
Rocks, south of Ushagat+	6/12	1033	P	55		
S. Ushagat+	6/12	1037	P	441		
N. Ushagat+	6/12	1043	V	0		
W. Amatoli	6/12	1045	V	0		
Sugarloaf*+	6/12	1050	P	1,319		nc
Sud	6/12	1100	V	0		
Cape Elizabeth	6/12	1110	P	85		
Nagahut Rocks	6/12	1115	P	28		
Perl	6/12	1118	P	97		
East Chugach	6/12	1121	P	39		
Gore Point	6/12	1133	P	63		
Outer*	6/12	1145	P	589		nc
Latax Rocks+	6/12	1340	P	519		
Dark	6/12	1342	V	0		
Sea Otter	6/12	1350	P	164		

Table 1. --Continued.

Location	Adult and juvenile Date	Time	Type[a]	Count	PUP Date	Count
Tonki	6/12	1400	V	14		
Sea Lion Rocks+	6/12	1402	P	93		
Long+	6/12	1425	P	93		
Marmot*+	6/13	1400	P	1,766		nc
Cape Chiniak+	6/14	0834	V	95		
Ugak	6/14	0845	V	0		
Gull Point	6/14	0855	P	91		
Cape Barnabas+	6/14	0905	V	1		
Two-headed+	6/14	0930	P	268		
Cape Sitkinak+	6/14	0945	P	234		
Tugidak	6/14	1010	V	0		
Nagai Rocks	6/14	1110	P	196		
Chirikof*+	6/14	1115	P	1,061	6/26	607
Chowiet*+	6/14	1150	P	897	6/27	344
Ugaiushak+	6/14	1415	V	55		
Sutwik+	6/14	1440	P	153		
Total				8,943		951
Western Gulf of Alaska						
Lighthouse Rock	6/14	1215	P	140		
Kak	6/14	1450	P	185		
Chankliut	6/14	1505	V	15		
Seal Cape	6/14	1515	V	0		

Table 1. --Continued.

Location	Adult and juvenile				Pup	
	Date	Time	Type[a]	Count	Date	Count
Mitrofania	6/14	1520	V	70		
Spitz+	6/14	1530	P	126		
Wosnesenski	6/16	1045	V	1		
Jude	6/16	1055	V	200		
Rock	6/22	1510	P	17		
Bird+	6/22	1518	P	134		
Sanak	6/22	1530	V	0		
South Rock	6/22	1533	V	332		
Cherni	6/22	1543	V	1		
Clubbing Rocks*+	6/22	1546	P	1,021		nc
Pinnacle Rock*+	6/22	1601	P	1,305		nc
Unga	6/23	1047	V	36		
Sea Lion Rocks+	6/23	1054	P	84		
Nagai+	6/23	1103	V	0		
Twins	6/23	1108	V	0		
Chernabura*+	6/23	1116	P	442	6/28	193
Atkins*+	6/23	1127	P	728	6/28	435
Castle Rock+	6/23	1136	P	75		
Haystacks	6/23	1147	V	0		
Whaleback	6/23	1150	P	419		
Total				5,331		628

Table 1. --Continued.

Location	Adult and juvenile				PUP	
	Date	Time	Type[a]	Count	Date	Count
Eastern Aleutian Islands						
Amak+	6/16	1010	P	228		
Sea Lion Rocks*+	6/16	1015	P	286		nc
Rocks between Amak and Sea Lion Rocks+	6/16	1020	V	45		
Unimak						
Oksenof Point	6/16	1224	V	36		
Cape Serichef	6/16	1240	V	15		
Cape Lutke	6/22	1500	V	0		
Ugamak*+	6/16	1250	P	915	6/30	851
Round+	6/16	1250	V	30		
Aiktak	6/16	1300	V	12		
Kaligigan	6/16	1303	V	1		
Tigalda	6/16	1305	V	71		
Rootok	6/16	1315	V	85		
Akutan						
Battery Point	6/16	1315	V	0		
Cape Morgan*+	6/16	1322	P	765	7/03	442
Reef Point+	6/16	1328	V	40		
Lava Bight	6/16	1329	V	0		
Akun						
Billings Head*+	6/16	1336	P	118	7/03	63

Table 1. --Continued.

Location	Adult and juvenile				Pup	
	Date	Time	Type[a]	Count	Date	Count
Tanginak	6/16	1340	V	27		
Outer Signal	6/16	1400	V	35		
Old Man Rocks	6/16	1402	V	89		
Egg	6/16	1403	V	0		
Baby	6/16	1406	V	0		
Unalaska						
Priest Rock	6/16	1421	V	0		
Cape Wislow	6/17	0957	V	0		
Bishop Point	6/17	1001	V	130		
Point Kadin	6/17	1348	V	1		
Makushin Bay	6/17	1340	P	172		
Cape Starichkof	6/17	1337	V	0		
Spray Cape	6/17	1333	V	0		
Cape Izigan	6/17	1310	P	278		
Bogoslof*+	6/17	1016	P	713	7/05	461
Emerald	6/17	1316	V	0		
Polivnoi Rock	6/17	1319	P	93		
Umnak						
Cape Idak	6/17	1031	V	21		
Cape Aslik+	6/17	1047	V	45		
Cape Kigunak	6/17	1050	V	1		
Cape Udak area	6/17	1248	V	4		

Table 1. --Continued.

Location	Adult and juvenile Date	Time	Type[a]	Count	PUP Date	Count
Adugak*+	6/17	1105	P	350	7/06	262
Samalga	6/17	1109	V	2		
Vsevidof+	6/17	1252	V	26		
Ogchul*+	6/17	1256	P	240		nc
Pillars	6/17	1303	V	1		
Total				4,875		2,079
Central Aleutian Islands						
Chuginadak+	6/17	1120	P	73		
Herbert+	6/17	1126	V	75		
Carlisle+	6/17	1220	V	40		
Uliaga	6/17	1225	V	29		
Kagamil+	6/17	1230	V	23		
Yunaska*+	6/17	1205	P	391	7/07	230
Chagulak+	6/17	1155	V	31		
Amukta+	6/17	1147	V	59		
Seguam						
Saddleridge*+	6/20	1156	P	833	7/08	684
Other+	6/20	1200	V	181		
Agligadak +	6/20	1215	P	274	7/09	0
Tanadak+	6/20	1220	V	60		
Sagigik+	6/20	1226	P	66		

Table 1. --Continued.

Location	Adult and juvenile				PUP	
	Date	Time	Type[a]	Count	Date	Count
Amlia						
East Cape+	6/20	1219	V	40		
Sviechnikof*	6/20	1232	P	214	7/09	26
West Cape+	6/20	1244	V	9		
Amtagis	6/20	1257	V	0		
Sagchudak	6/20	1300	V	0		
Atka						
Cape Korovin+	6/20	1312	V	0		
North Cape+	6/20	1317	P	153		
Salt+	6/20	1330	V	0		
Koniuji	6/20	1342	V	0		
Kasatochi*+	6/20	1350	P	641	7/10	178
Ikiginak+	6/20	1400	V	0		
Anagaksik+	6/20	1410	P	33		
Little Tanaga						
SE Point+	6/20	1415	V	2		
Straits+	6/20	1420	P	53		
Kagalaska	6/20	1426	P	27		
Great Sitkin	6/20	1433	V	50		
Adak						
Cape Moffet+	6/20	1728	V	0		
Argonne Point+	6/20	1734	V	0		

Table 1. --Continued.

Location	Adult and juvenile				PUP	
	Date	Time	Type[a]	Count	Date	Count
Adak						
Lake Point*+	6/20	1742	P	592	7/11	137
Tanaga						
Cape Sasmik	6/20	1805	P	148		
Bumpy Point	6/20	2103	V	43		
Ilak	6/20	1814	V	15		
Gramp Rock*+	6/20	1815	P	712	7/16	448
Ulak						
Hasgox Point*+	6/20	1828	P	1,324	7/12	790
Amatignak+	6/20	1834	V	37		
Dinkum Rocks+	6/20	1850	V	31		
Unalga+	6/20	1851	P	60		
Kavalga+	6/20	1901	V	8		
Skagul+	6/20	1909	V	0		
Tag*+	6/20	1907	P	478	7/12	357
Ugidak+	6/20	1911	V	110		
Gareloi	6/20	1921	V	0		
Amchitka						
Ivakin Point+	6/20	1958	V	0		
East Cape+	6/20	1959	V	106		
Column Rocks*	7/13	1800	B	197	7/13	148
Ayugadak*+	7/14	1100	B	401	7/14	163

Table 1. --Continued.

Location	Adult and juvenile Date	Time	Type[a]	Count	PUP Date	Count
Kiska						
Cape St. Stephens*+	7/15	1140	B	564	7/15	212
Lief Cove*+	7/15	1900	B	528	7/15	221
Total				8,711		3,594
Total all areas				27,860		7,252

[a]P = aerial photo count; V = aerial visual count; B = boat count

Table 2. --Counts of adult and juvenile northern sea lions observed at 77 rookery and haul-out sites between the Kenai Peninsula and Kiska Island during June and July aerial surveys from 1956 to 1990. Only sites counted in all surveys are included (Table 1).

Year	Source	Gulf of Alaska		Aleutian Islands		Total
		Central	Western	Eastern	Central	
1956	1		15,772			
1957	1	34,792		37,605		105,289[a]
1959	2				17,120	
1960	2			44,020		
1962	3				23,175	
1975	4			19,769		
1976	4,5	24,678	8,311	19,743		89,364[b]
1977	4			19,195		
1979	6				36,632	
1985	7	19,002	6,275	7,505	23,042	55,824
1989	8	8,552	3,908	3,032	7,572	23,064
1990	9	7,050	3,915	3,801	7,988	22,754
Change:						
Overall		-80%	-75%	-90%	-53%	-78%
Annual						
1956-59 to 1990		-5%	-4%	-7%	-2%	-5%
1985 to 1990		-18%	-9%	-13%	-19%	-16%
1989 to 1990		-18%	0%	+25%	+5%	-1%
Correlation						
1956-59 to 1990		-0.949[c]	-0.995[c]	-0.982[c]	0.324	-0.915[c]

Sources: 1--Mathisen and Lopp (1963); 2--Kenyon and Rice (1961); 3--Kenyon (1962); 4--Braham et al. (1980); 5--Calkins and Pitcher (1982); 6--Fiscus et al. (1981); 7--Merrick et al. (1987); 8--Laughlin et al. (1990); 9--this study

[a]Sum of regional counts from 1956 through 1959.

[b]Sum of regional counts from 1976 through 1979.

'Significant trend ($P < 0.05$) from 1956-59 to 1990:

Table 3. --Counts of adult and juvenile northern sea lions at principal rookeries between the Kenai Peninsula and Kiska Island during June and July aerial surveys from 1956 to 1990. Only sites counted in all surveys are included (see Table 1). Wilcoxon test used to compare 1989 and 1990 counts.

Year	Source	Gulf of Alaska		Aleutian Islands		Total
		Central	Western	Eastern	Central	
1956	1		14,499			
1957	1	23,538		34,420		80,482[a]
1959	2				8,025	
1960	2			43,220		
1962	3				8,940	
1975	4			17,452		
1976	4,5	19,479	7,125	17,745		71,455[b]
1977	4			17,370		
1979	6				27,106	
1985	7	12,379	4,888	6,975	15,392	39,634
1989	8	6,207	3,521	2,813	6,106	18,647
1990	9	5,043	3,496	3,417	6,738	18,694
Change:						
Overall		-79%	-76%	-90%	-16%	-77%
Annual						
1956-59 to 1990		-5%	-4%	-7%	1%	-4%
1985 to 1990		-16%	-7%	-13%	-15%	-14%
1989 to 1990		-19%	-1%	+21%	+10%	0%
Correlation						
1956-59 to 1990		-0.927[c]	-0.997[c]	-0.972[c]	0.064	-0.910[c]
Wilcoxon W						
statistic		20	19	49	110	637
n,m		4,4	4,4	7,7	10,10	25,25
p		0.665	0.885	0.702	0.738	1.000

Sources: 1--Mathisen and Lopp (1963); 2--Kenyon and Rice (1961); 3--Kenyon (1962); 4--Braham et al. (1980); 5--Calkins and Pitcher (1982); 6--Fiscus et al. (1981); 7--Merrick et al. (1987); 8--Laughlin et al. (1990); 9--this study

[a]Sum of regional counts from 1956 through 1959.
[b]Sum of regional counts from 1975 through 1979.
[c]Significant trend ($P < 0.05$) from 1956-59 to 1990.

Table 4.--Counts of northern sea lions at principal rookeries in the Aleutian Islands and Gulf of Alaska for 1985-90.

Island	1985[a]	1989[b]	1990	Percent change[c]
Outer[d]	nc	350[e]	589	(+68)
Sugarloaf	2,991	1,861	1,319	-56(-29)
Marmot	4,983	2,331	1,766	-65(-24)
Chowiet	2,059	737	897	-56(+22)
Chirikof	2,346	1,278[e]	1,061	-55(-17)
Atkins	1,562	755	728	-53(- 4)
Chernabura	487	544	442	- 9(-19)
Pinnacle Rock	1,588	1,366	1,305	-18(- 4)
Clubbing Rocks	1,251	856	1,021	-18(+19)
Sea Lion Rock	538	344	286	-47(-17)
Ugamak[f]	1,503	450[e]	945	-37(+110)
Akun	435	150[e]	118	-73(-21)
Akutan	1,710	578[e]	765	-55(+32)
Bogoslof	1,287	682	713	-45(+ 5)
Ogchul	547	217	240	-56(+11)
Adugak	955	392	350	-63(-11)
Yunaska	1,071	466	391	-63(-16)
Seguam	2,942	602	833	-72(+38)
Agligadak	514	132	274	-47(+108)
Kasatochi	1,170	659	641	-45(- 3)
Adak	964	424	592	-39(+40)

Table 4. --Continued.

Island	1985[a]	1989[b]	1990	Percent change[c]
Gramp	1,290	747	712	-45(- 5)
Tag	944	590	478	-49(-19)
Ulak	2,729	1,123	1,324	-51(+18)
Amchitka[d]	728	nc	197	-73(---)
Ayugadak	702	389	401	-43(+ 3)
Kiska: Lief & Cape St. Stephens	3,066	974	1,092	-64(+12)
Total	39,634[g]	18,647[g]	18,694[g]	-53(0)

[a]Loughlin et al. (1986) and Merrick et al. (1987).

[b]Loughlin et al. (1990).

[c]1990/1985(1990/1989).

[d]Data not used in trend analysis.

[e]Poor quality photographs.

[f]Includes Round Island.

[g]Does not include Amchitka and Outer Islands.

nc = no count.

Table 5. --Counts of northern sea lion pups observed at selected rookeries from Chirikof to Kiska Islands during June and July surveys from 1985 to 1990.

Area or island	1985[a]	1989[b]	1990	Percent change 1985-90	Percent change 1989-90
Central Gulf of Alaska					
Chirikof	1,913		607	-68	
Chowiet	3,207		344	-89	
Total	5,120		951	-81	
Western Gulf of Alaska[c]					
Atkins	2,093		433	-79	
Chernabura	200		200	0	
Total	2,293		633	-72	
Eastern Aleutian Islands					
Ugamak	1,635		851	-48	
Akun	60		63	+ 5	
Akutan	1,130		442	-61	
Bogoslof	1,109	358	461	-58	+29
Adugak	844		262	-69	
Total	4,778		2,079	-56	
Central Aleutian Islands					
Yunaska	1,026		230	-78	
Seguam	2,635	529	684	-74	+29
Agligadak	>30		0	--	
Kasatochi	892		178	-80	
Adak - Lake Point	558		137	-75	

Table 5. --Continued.

Area or island	1985[a]	1989[b]	1990	Percent change 1985-90	Percent change 1989-90
Tag	703		352	-50	
Ulak	1,236		790	-36	
Gramp	909		448	-51	
Ayugadak	329		163	-50	
Kiska					
Lief Cove	882	293	221	-75	-25
Total	9,200		3,208	-65	
Total all sites	21,391		6,871	-68	

[a]Loughlin et al. (1986) and Merrick et al. (1987),
[b]Merrick et al. (1990).
[c]Counts labelled as 1985 were made in 1984.

Table 6. --Harbor seals counted at sites during June and July 1990 northern sea lion surveys.

Island	Date	Time	Number
Ugak	6/14	0845	168
Tugidak	6/14	1010	314
Sanak	6/22	1530	24+
Cherni	6/22	1543	4
Clubbing Rocks	6/22	1546	4
Nagai	6/22	1103	1
Kaligigan	6/16	1303	20
Akun			
Billings Head	7/03	1307	1
Baby	6/16	1406	25
Priest Rock	6/16	1421	6
Bogoslof	7/05	1100	1
Unalaska			
Cape Starichkof	6/17	1337	7
Makushin Bay	6/17	1340	2
Point Kadin	6/17	1348	4
Umnak			
Cape Ugdak	6/17	1248	1
Vsevidof	6/17	1252	8
Samalga	6/17	1109	5
Seguam	6/20	1200	10

Table 6. --Continued.

Island	Date	Time	Number
Amlia			
East Cape	6/20	1244	1
Sviechnikof	7/07	1330	1
Adak			
Argonne Point	6/20	1300	10
Kavalga	6/20	1401	1
Total			618

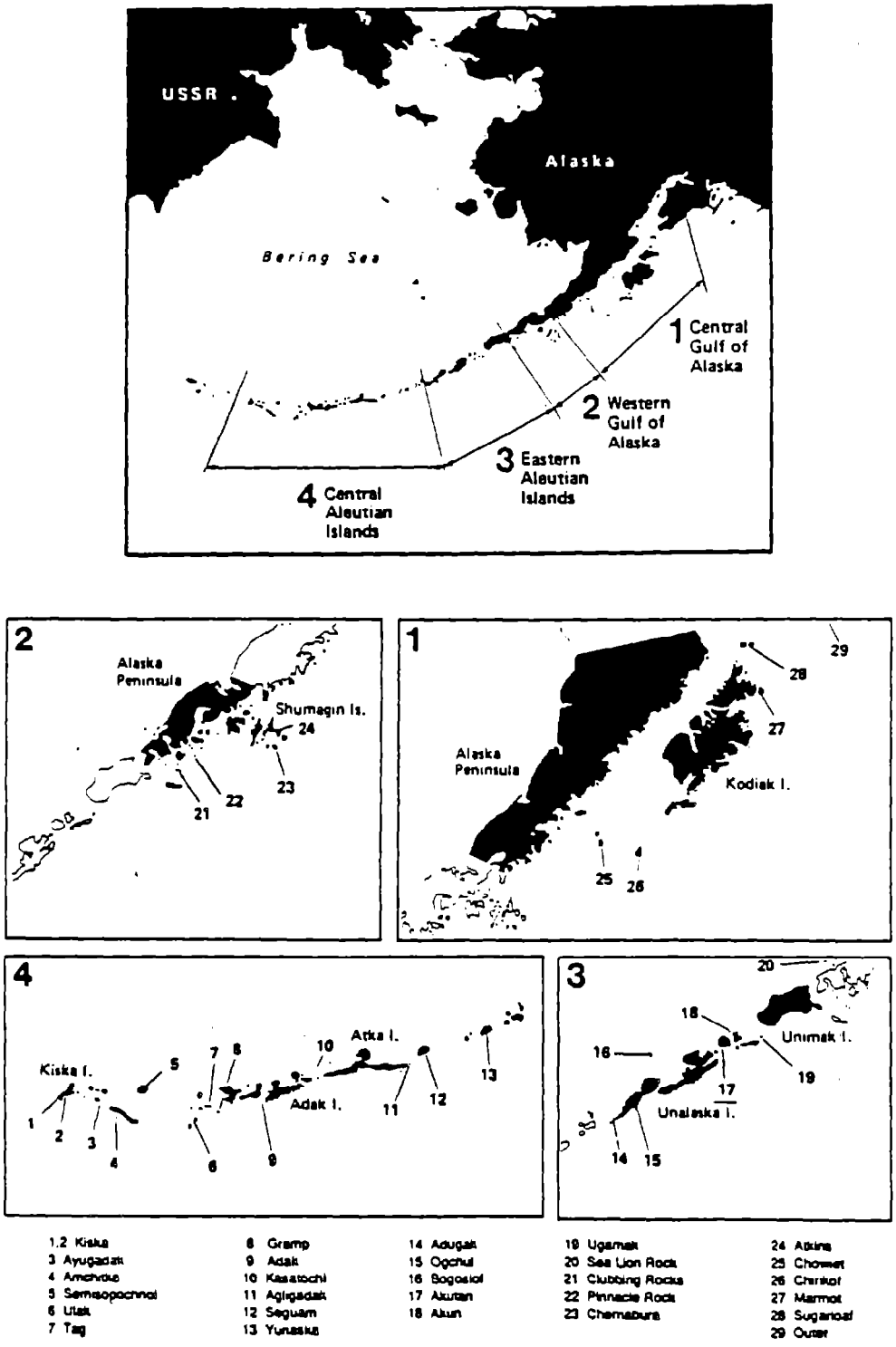

Figure 1.--The four Alaskan regions and northern sea lion rookeries counted during 1990, as modified from Merrick et al. (1987).

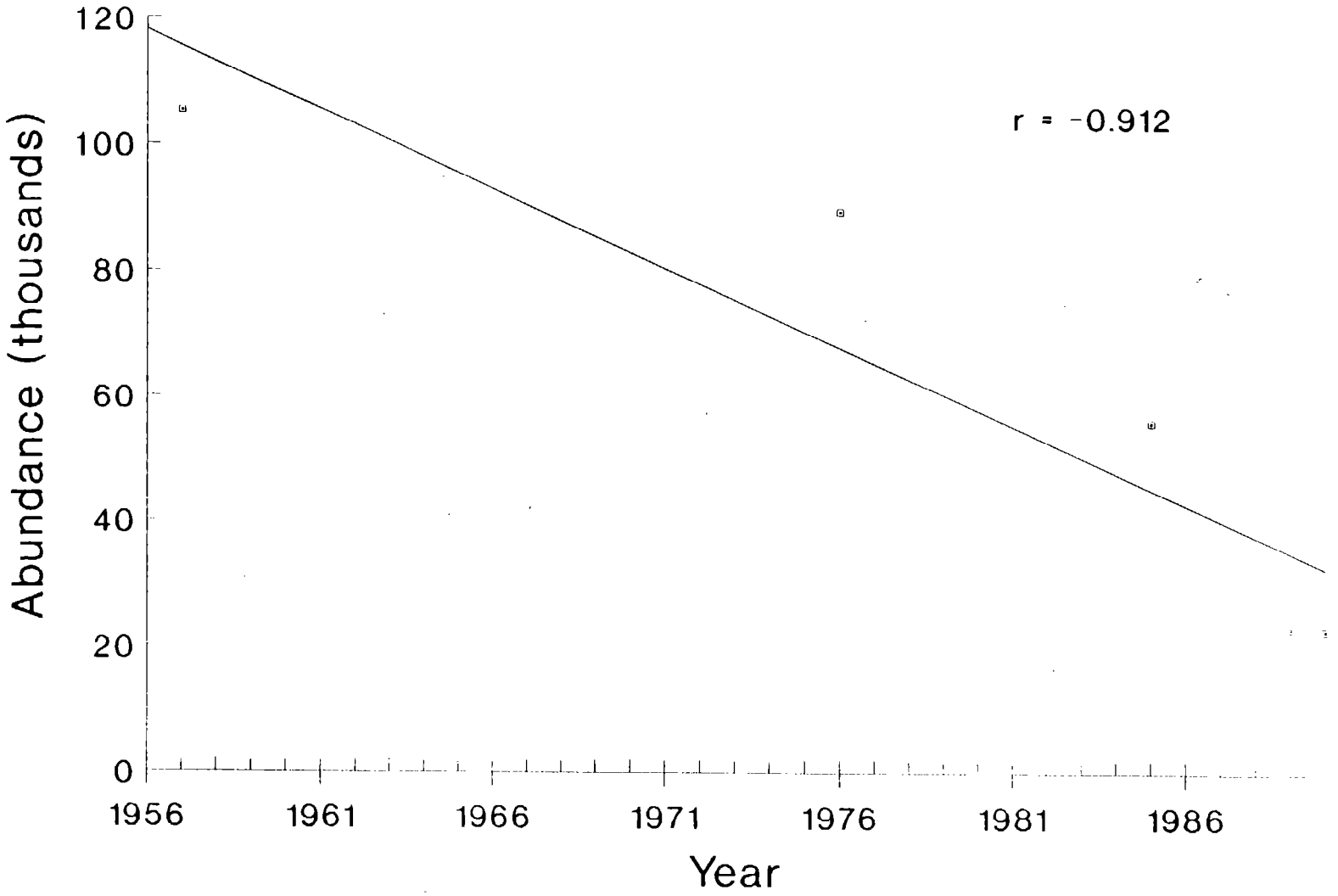

Figure 2. --Overall trend in northern sea lion abundance from the Kenai Peninsula to Kiska Island, 1956-90 using data from 77 selected rookeries and haul outs.

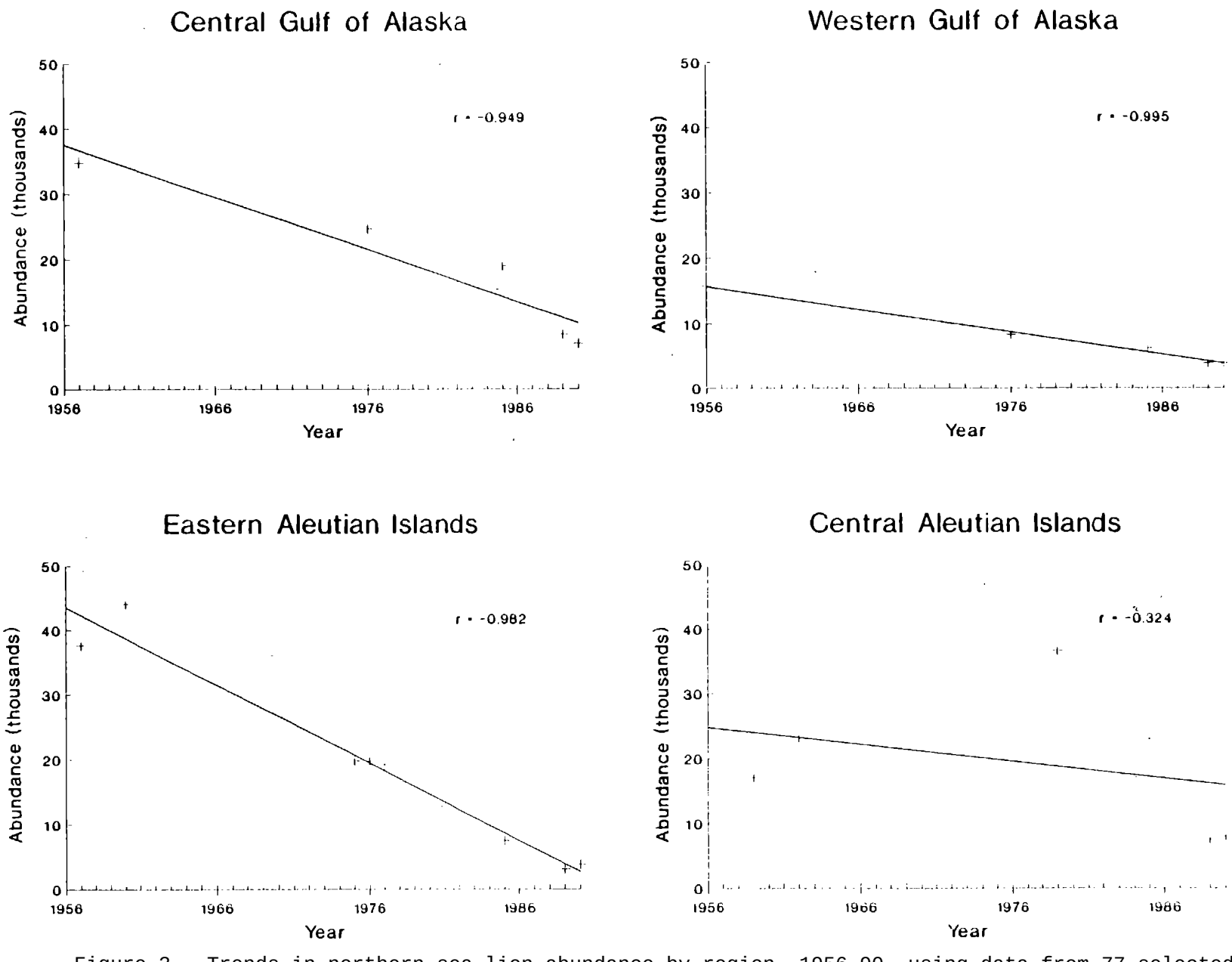

Figure 3.--Trends in northern sea lion abundance by region, 1956-90, using data from 77 selected rookeries and haul outs.