



NOAA Technical Memorandum NMFS-AFSC-17

Aerial and Ship-based Surveys of Steller Sea Lions (*Eumetopias jubatus*) in Southeast Alaska, the Gulf of Alaska, and Aleutian Islands During June and July 1992

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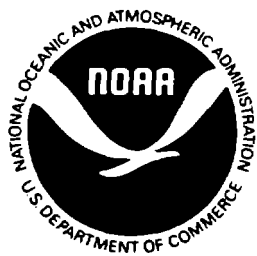
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Aerial and Ship-based Surveys of Steller Sea Lions (*Eumetopias jubatus*) in Southeast Alaska, the Gulf of Alaska, and Aleutian Islands During June and July 1992

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ABSTRACT

Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) were conducted during June and July 1992 from Forrester Island in Southeast Alaska to Attu Island in the western Aleutian Islands. A total of 34,844 adult and juvenile sea lions were counted at 95 "trend sites" (sites surveyed consistently since the 1970s and are thus appropriate for monitoring trends). The 1992 count represents a decline of 70.2% from 1979 (116,804) and a decline of 4.4% ($P = 0.043$) from 1991 (36,459). The annual rate of decline from 1979 to 1992, based on linear regression, was 9.6% ($P = 0.0026$). Of the 95 trend sites, 32 are rookeries. Estimated annual rates of decline for these rookeries were 10.2% ($P < 0.001$) for 1979-92 and 5.4% ($P = 0.06$) for 1989-92. Sixty-nine of the trend sites are located between the Kenai Peninsula and Kiska Island. At these sites, we counted 20,679 adult and juvenile sea lions, which represents declines of 76.9% from the 1975-79 counts (89,364) and 4.9% ($P = 0.034$) from 1991 (21,737). Estimated annual rates of decline, based on linear regression, were 10.0% ($P = 0.002$) for 1975-79 to 1992 and 3.7% ($P = 0.026$) for 1989 to 1992. For 26 trend rookeries in the Kenai to Kiska area, estimated annual rates of decline were 9.8% ($P < 0.001$) for 1975-79 and 4.4% ($P = 0.067$) for 1989-92. During the past year, numbers of sea lions counted at trend sites increased only in the eastern Aleutian Islands (from 4,231 in 1991 to 4,839 in 1992) and the western Aleutian Islands (from

2,411 to 2,869). Counts at trend sites declined in Southeast Alaska (from 7,715 in 1991 to 7,558 in 1992), in the eastern Gulf of Alaska (from 4,596 to 3,738), in the central Gulf of Alaska (from 6,273 to 5,721), and in the central Aleutian Islands (from 7,499 to 6,399). Counts of sea lions in the western Gulf of Alaska in 1991 and 1992 remained essentially unchanged (3,734 and 3,720, respectively). We counted 2,951 live pups at six rookeries in 1992. The number of pups increased at three of the four rookeries last surveyed in 1990: Akutan-Cape Morgan (+25.8%), Chernabura (+8.8%), and Chowiet (+9.1%) and declined sharply at Sugarloaf Island (-46.6%). Regionally, numbers of pups increased in Southeast Alaska (+24.2%), in the eastern (+16.9%) and western Gulf of Alaska (+13.9%), and in the eastern Aleutian Islands (+9.3%), but declined in the central Gulf of Alaska (-29.3%) from 1989-90 to 1991-92. Overall the number of pups declined by 4.4%, the same rate that the number of adult and juvenile sea lions declined from 1991 to 1992.

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INTRODUCTION

Summer surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska have been conducted sporadically since the late 1950s (Merrick et al. 1987). The number of animals in most areas has shown a relatively continuous decline from the 1970s through at least 1989 (Merrick et al. 1987, Loughlin et al. 1990, Merrick et al. 1992). The extent of this decline resulted in the listing of Steller sea lions as threatened under the Endangered Species Act in November 1990 (55 FR 49204). As a result of this listing, a Steller Sea Lion Recovery Team was formed with a primary mission of preparing a plan for the recovery of the species (NMFS 1992). One recommendation of the Steller Sea Lion Recovery Plan was continuation of surveys to monitor the Alaskan population.

This report presents results of aerial and ship-based surveys conducted during 1992. Counts were made of adult and juvenile Steller sea lions at 247 rookeries and haul-out sites from Forrester Island in Southeast Alaska to Attu Island in the western Aleutian Islands (Fig. 1). Pups were counted at six selected rookeries. The 1992 surveys supplement the results from previous surveys by the National Marine Mammal Laboratory of the National Marine Fisheries Service (NMFS) and the Alaska Department of Fish and Game (ADF&G) (Calkins and Pitcher 1982, Loughlin et al. 1986, Merrick et al. 1987, Loughlin et al. 1990, Merrick et al. 1991, Merrick et al. 1992, ADF&G¹). As with the

¹ADF&G, unpubl. data. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518.

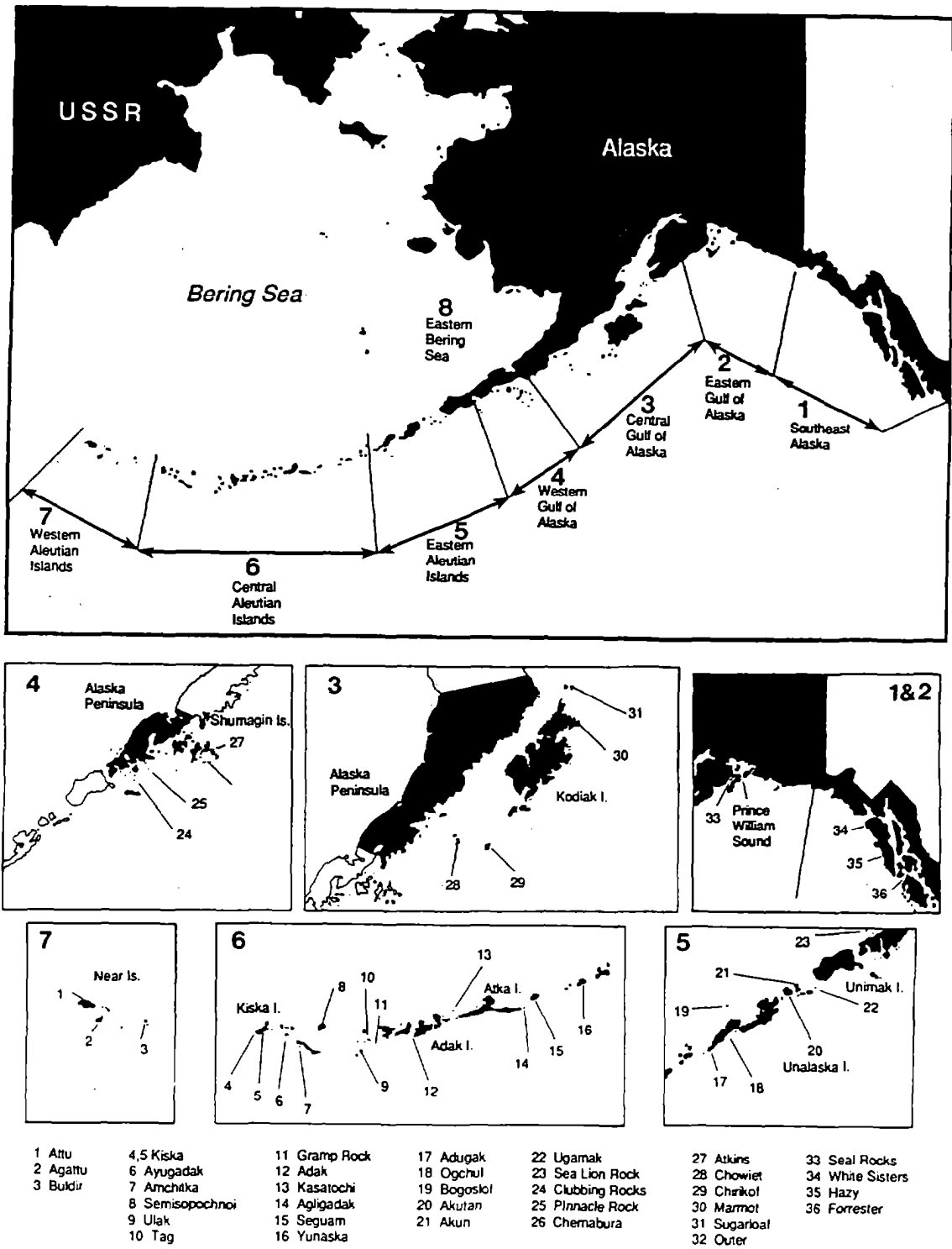


Figure 1.--Eight regions of Alaska showing major Steller sea lion rookeries, as modified from Merrick et al. (1987).

report from the 1991 survey, this report focuses on counts of adult and juvenile sea lions at particular rookeries and haul-out areas that were selected for population trend analysis (Merrick et al. 1992).

The one significant departure in 1992 from the standardized protocol used in previous years was the introduction of repetitive aerial surveys Alaska-wide. A group of population biologists and statisticians at the NMFS Alaska Fisheries Science Center (AFSC) reviewed the existing protocol and suggested that the aerial survey procedure be modified to include repetitive surveys. The principal reason for this modification was to estimate survey variability. The AFSC group also examined existing data sets that contained repetitive counts and determined that the relative value of additional counts diminished rapidly after two surveys. That is, reduction in the coefficient of variation (CV) with three or more surveys would not offset increased survey cost and risk to participants.

The AFSC statistical group's revised survey protocol underwent a second scientific review led by the office of the Chief Scientist, NMFS. This review group included population biologists and statisticians from the NMFS, other Federal agencies, and the Department of Fisheries and Oceans, Canada. The very low CVs of existing survey and count data led this review group to conclude that replication of surveys was likely

to provide negligible improvement over the standard protocol of previous surveys (Rosenberg²).

Despite this conclusion, the AFSC decided to proceed with a duplicate survey in 1992 in order to collect data for analyses of survey techniques and various aspects of sea lion attendance at rookeries and haul-out sites. Of particular interest were 1) providing a CV for surveys, 2) increasing the power to detect trends through statistical testing procedures, 3) studying optimal survey dates, and 4) examining phenology of site attendance by sea lions during the breeding season.

METHODS

Analyses contained in this report focus on "trend sites." These trend sites are major rookeries and haul-out sites that have been counted consistently during recent survey years. Rookeries are those sites where adult males actively defend territories, pups are born, and mating takes place. Haul-out sites are those where sea lions predictably leave the water but where few or no pups are born (Calkins and Pitcher 1982, Loughlin et al. 1984).

Protocols for the 1992 surveys generally followed the rationale and methods of earlier aerial and on-land surveys

²A.A. Rosenberg, unpubl. memorandum to M.P. Sissenwine and W. Aron, 13 July 1992. Final report of the Steller sea lion workshop. National Marine Fisheries Service, 1335 East-West Highway, Silver Spring, MD 20910.

(Braham et al. 1980, Calkins and Pitcher 1982, Withrow 1982). Several modifications made during 1992 for the aerial surveys are described below.

Aerial Surveys

Adult and juvenile Steller sea lions were counted and photographed from an aircraft flying over rookeries and haul-out sites from Forrester Island (Southeast Alaska) to Attu Island (western Aleutian Islands) during 10 June and 5 July 1992 (Fig. 1, Tables 1 and 2). Although flights were designed to visit traditional sea lion rookeries and haul-out areas (Calkins and Pitcher 1982, Loughlin et al. 1984), potential haul-out sites along the flight path were examined en route. Under ideal conditions, flights were conducted at approximately 200 m altitude, 100-120 knots air speed, and 500 m offshore. Strong winds occasionally required flying at higher altitudes or farther offshore, whereas fog sometimes required flying at a lower altitude or closer inshore. Sea lions typically are not disturbed by aircraft that fly above 200 m.

Sea lions were photographed using a 35-mm, autofocus camera with a motor drive and 70-210 mm zoom lens. Where appropriate, sequential slides overlapped slightly to guarantee complete coverage of the site. **NMFS** survey personnel also photographed each site using high-resolution, 8-mm video cameras. Video recordings provided an overview of the entire site and served as backup in case the 35-mm slides were unusable. If either of the

photographers (i.e., 35-mm or video) was not confident that the site was adequately covered, a second pass was made. At sites with fewer than about 25 animals, the number of animals typically was counted or estimated visually and 35-mm photographs were not taken. Identifying frame numbers for the 35-mm film and counters for video tape were recorded immediately upon departure from each site. The 35-mm and video cameras used by the NMFS survey teams included a "data back" feature that imprinted date and time on the images. Except at sites with few animals (25 or fewer), NMFS survey personnel did not visually estimate the number of animals at each site. This was a departure from the protocol of previous surveys. ADF&G personnel made visual estimates after photographing with a 35-mm camera. ADF&G personnel did not make video recordings.

The addition of replicate surveys in 1992 required the use of additional survey teams. Previously, a single NMFS team surveyed from Outer Island, off the Kenai Peninsula, westward to Attu Island in the western Aleutian Islands while the ADF&G team surveyed from the Barren Islands (between the Kenai Peninsula and the Kodiak Archipelago) eastward and southward to Forrester Island in Southeast Alaska. Thus the two survey teams overlapped from the Barren Islands to Outer Island. In 1992, the NMFS and ADF&G each used two survey teams to cover four areas: Attu Island to Unimak Island (NMFS), Unalaska Island to Outer Island (NMFS), the Barren Islands to Yakutat (between the eastern Gulf of Alaska and Southeast Alaska) (ADF&G), and Yakutat to Forrester

Island (ADF&G). Trend sites in each region were surveyed at least twice, except Forrester Island, Cape Fairweather, and Harbor Point in Southeast Alaska, which were surveyed once.

Photographs were analyzed in the laboratory using the same protocol as in previous years. For the NMFS surveys, slides were projected onto a white background. Counters outlined overlap between photographs and marked individual animals on the projected images as they counted. Only adults and juveniles on land or in the surf zone were counted. At least two counters independently counted sea lions in each series of photographs for each site. Counters repeated the process for any site when their results differed by 10% or more. The final count for each rookery or haul-out is the mean of all individual counts--one for each counter for each series of photographs. For example, each NMFS survey team made two visits to the trend rookery at Cape Morgan on Akutan Island (Table 2). Two counters analyzed the photographs from each of four visits, resulting in eight individual counts. Nagai Rocks, in the Gulf of Alaska, is not a trend site. It was surveyed only once, resulting in two individual counts. All mean counts were rounded to the nearest integer for summarization and analysis.

Counting protocol for the ADF&G surveys was slightly different from that of the NMFS surveys. During analysis, ADF&G counters marked overlap directly on transparencies rather than on the projected image. Within each replicate survey, ADF&G counters used the first count for each site. A second person

counted the sea lions for each site, but only to verify the accuracy of the first count, not to calculate a mean. An individual site was recounted whenever the difference between counts exceeded about 3-5%. Approximately one-third of the replicates were not verified. These primarily were sites with few animals or uncomplicated geography that facilitated an easy count.

The final count for each site (Table 2), which was used in all analyses, is the mean of the counts from replicate surveys. A coefficient of variation (CV) was calculated for the mean count in each region by squaring the standard error of the mean for each site and summing those values for all sites in the region. The CV is the square root of that sum divided by the mean count for that region.

Ship-supported On-land Surveys

Counts of sea lion pups were obtained by NMFS and ADF&G survey teams between 26 June and 16 July at six rookeries from White Sisters Island (Southeast Alaska) to Akutan Island (eastern Aleutian Islands). Pup counts at White Sisters Island were made by a survey team transported to the beaches by helicopter. Surveys at the five other rookeries (Sugarloaf to Akutan Islands) were supported by the charter vessel M/V Maritime Maid. This vessel delivered the survey team to within 2-4 km of a site; the survey team then went ashore using small inflatable boats. Protocol was similar in all surveys. After all sea lions other

than pups were cleared from the beach, biologists (usually three) independently counted live pups on the beach and in the water. The final count for a site represents the mean of all counts made.

Data Analysis

Geographical regions used for analysis of trends in abundance of sea lions were the same as those used for previous survey reports (Merrick et al. 1987, Loughlin et al. 1990, Merrick et al. 1991, Merrick et al. 1992) and those adopted by the Steller Sea Lion Recovery Plan (NMFS 1992). Coastal Alaska includes eight regions: Southeast Alaska; eastern, central, and western Gulf of Alaska; eastern, central, and western Aleutian Islands; and the eastern Bering Sea (Fig. 1). The eastern Bering Sea region, which contains few haul-out areas and only one rookery (Walrus Island in the Pribilof Islands), was not surveyed in 1992 and does not appear in the following analyses. The other seven regions were surveyed completely in 1992. Of the 247 sites visited, 95³ have been counted consistently in all recent surveys. These sites also include the majority of animals observed (75.9% in 1992). Accordingly, we defined these as trend sites (Table 2). Most of the other areas are small haul-out sites. The only significant exceptions are the rookeries at Outer, Amchitka (Column Rocks and East Cape), Semisopochnoi,

³Some of the 103 trend sites reported in Merrick *et al.* (1992) (e.g., Ugamak and Round islands) are combined as one trend site here (Table 2).

Agattu (Gillon Point), and Attu Islands. These rookeries were excluded from the list of trend sites because they were not counted consistently during previous surveys.

Another geographical region used during analyses of survey data is the area from the Kenai Peninsula to Kiska Island. This area was used as an index for population trends because it encompassed the center of the Steller sea lions' range and included the major component of the Alaska sea lion population (64.2% of animals on trend rookeries and 59.3% of animals on all trendsites in 1992). The Kenai to Kiska area includes four of the smaller regions: the central and western Gulf of Alaska and the eastern and central Aleutian Islands.

Analyses to determine population trends were performed for the sums of all trend sites (rookeries and haul-out sites) and the sums of rookery trend sites for all of Alaska and for the Kenai to Kiska area. The change from 1991 to 1992, and the overall changes from the 1970s to 1992 and from 1989 to 1992, were expressed as a percent of the earlier estimate. Annual rate of change from the 1970s to 1992 and from 1989 to 1992 was estimated by the slope of a simple linear regression of the natural log of counts on survey year. The null hypothesis of no change in abundance during a time period was tested using the significance of the slope for the regression.

Significance of change from 1991 to 1992 was analyzed using a modified Student's t-test:

$$t_{d.f.} = \frac{C_{91} - C_{92}}{s.d.(C_{91} - C_{92})},$$

where t is the test statistic;
 $d.f.$ is the degrees of freedom (the number of sites in the region under investigation - 1);
 C_{91} and C_{92} are the 1991 and 1992 counts, respectively; and
 $s.d.(C_{91} - C_{92})$ is the standard deviation for the difference between the 1991 and 1992 counts.

Because the 1991 survey included no replication, no measure of variability is available for that year. For the analyses presented here, we assumed that the CV for the 1991 survey would have been the same as that for 1992. Thus, the denominator in the above equation is estimated by the following:

$$\begin{aligned} s.d.(C_{91} - C_{92}) &= [\text{var}(C_{91}) + \text{var}(C_{92})]^{1/2} \\ &= [(CV_{92}C_{91})^2 + (CV_{92}C_{92})^2]^{1/2}, \end{aligned}$$

where $\text{var}(C_{91})$ and $\text{var}(C_{92})$ are the variances for the 1991 and 1992 counts, and
 CV_{92} is the coefficient of variation for the 1992 count.

Percent changes reported for counts of adults and juveniles and for counts of pups at specific rookeries are the overall changes for the time period, expressed as a percent of the earlier count. In most cases, pups are counted at a particular rookery on alternate years. Thus, a 2-year cycle is required for

a complete series of counts. When counts were available for consecutive years (e.g., for 1989 and 1990), the mean was calculated.

Differences between counts were considered significant for probabilities less than or equal to 0.1. Statistical tests were performed to determine whether trends were significant, not whether the trend was of a particular magnitude. We did not attempt to test the statistical significance of small inter-annual trends over short time frames (e.g., less than 5% over a 3-year period), nor did we attempt to test the significance of trends for the seven smaller regions of Alaska. Repeated testing of data from nested subsets can create problems for interpretation of significance levels. In addition, the geographical divisions between regions are somewhat arbitrary and may not accurately reflect the underlying structure of stocks or other subunits of the population, if they exist.

RESULTS

Adult and Juvenile Surveys

Alaska Statewide

A total of 34,844 adult and juvenile sea lions were counted in 1992 at 95 trend sites from Southeast Alaska through the western Aleutian Islands (Table 2). This represents declines of 70.2% from the 116,804 animals counted at the same sites in 1975-79 and 4.4% from the 36,459 animals counted in 1991 (Fig. 2, Table 3). The difference between the 1991 and the 1992 counts

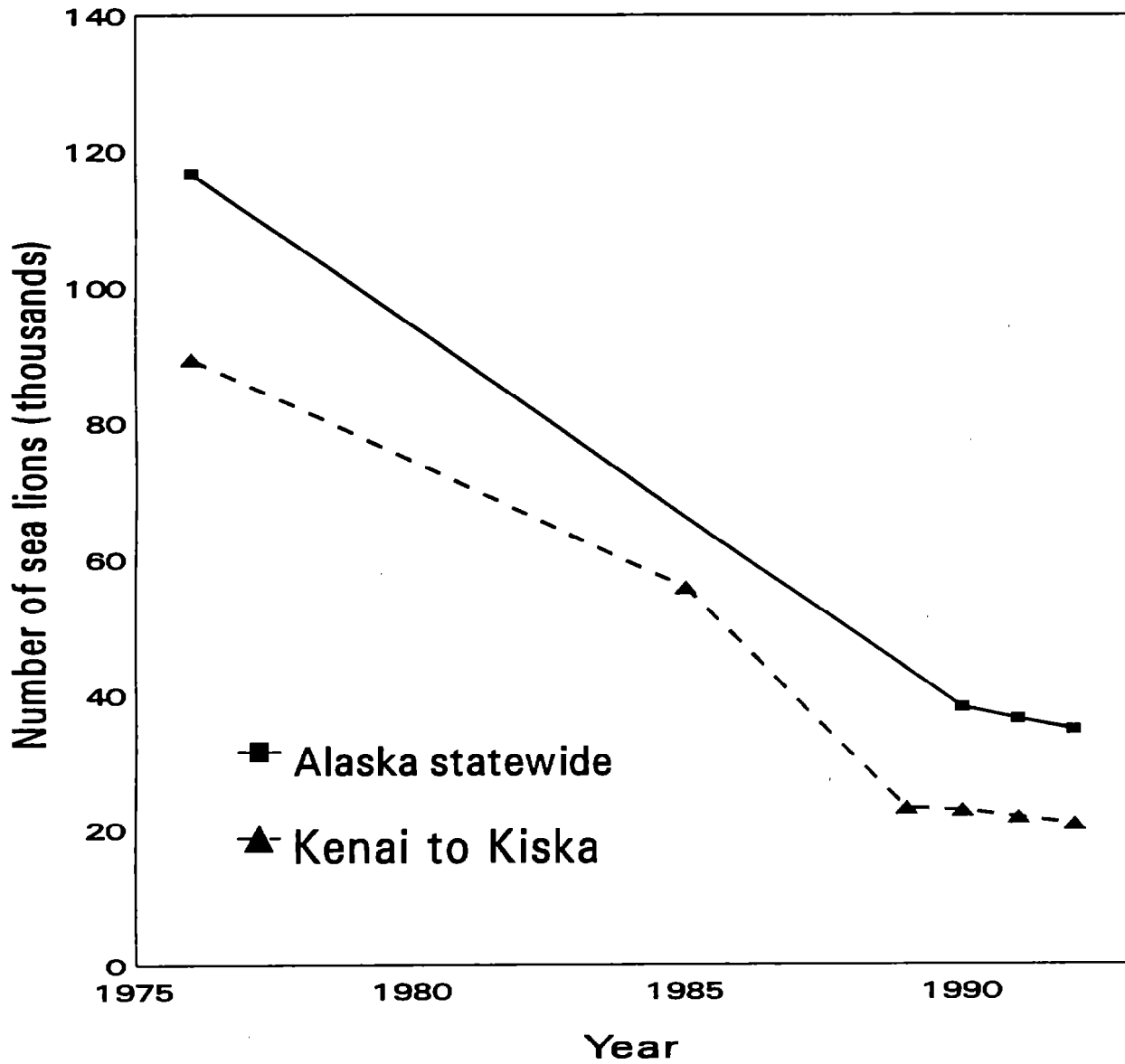


Figure 2. --Overall trend in Steller sea lion abundance, based on counts at trend rookeries and haul-out sites, for Alaska statewide and for the Kenai to Kiska area.

was significant ($P = 0.0427$). The annual rate of decline from 1975-79 through 1992, estimated at 9.6% by linear regression, was significant ($r = 0.997$, $P = -0.0026$).

The 95 trend sites include 32 rookeries (Table 2). The 25,849 adult and juvenile sea lions counted at these rookeries in 1992 represent overall declines of 71.5% from the 90,821 counted in 1975-79, 14.9% from the 30,388 in 1989, and 1.0% from the 26,099 in 1991 (Table 3). The annual rates of change, estimated by linear regression, were significant for 1975-79 to 1992 (-10.2%; $r = 0.994$, $P < 0.001$) and for 1989-92 (-5.4%; $r = 0.940$, $P = 0.060$).

Kenai to Kiska Area

Within the Kenai to Kiska area, a total of 20,679 sea lions were counted at 69 trend sites in 1992. These animals represented 59.3% of the total counted at all trend sites in Alaska. The 1992 count showed declines of 76.9% from the 89,364 animals counted at these sites in 1975-79, 10.3% from the 23,064 animals counted in 1989, and 4.9% from the 21,737 animals counted in 1991 (Fig. 2, Table 3). The decline from 1991 to 1992 was significant ($P = 0.0335$). Annual rates of decline, estimated by linear regression, were significant for 1975-79 to 1992 (-10.0%; $r = 0.961$, $P = 0.002$) and for 1989 to 1992 (-3.7%; $r = 0.974$, $P = 0.026$).

Of the sea lions counted at trend sites in the Kenai to Kiska area, 5,721 (27.7%) were in the central Gulf of Alaska,

3,720 (18.0%) in the western Gulf of Alaska, 4,839 (23.4%) in the eastern Aleutian Islands, and 6,399 (30.9%) in the central Aleutian Islands (Table 4). Counts in each region declined from the 1970s to 1992, ranging from a decline of 55.2% in the western Gulf of Alaska to 82.5% in the central Aleutian Islands (Fig. 3A). Counts also decreased during 1989 to 1992 in the central Gulf of Alaska (33.1%), in the western Gulf of Alaska (4.8%), and in the central Aleutian Islands (15.5%) but increased in the eastern Aleutian Islands (59.6%). From 1991 to 1992, numbers of sea lions continued to decline in the central Gulf of Alaska (8.8%) and in the central Aleutian Islands (14.7%), but remained essentially unchanged in the western Gulf of Alaska (-0.4%), and continued to increase in the eastern Aleutian Islands (14.4%).

The overall decline in numbers of sea lions also was apparent at rookeries. Of the 30 rookeries in the Kenai to Kiska area, 26 are used in trend analysis (Table 2). A total of 16,589 sea lions were counted at 26 trend rookeries in the Kenai to Kiska area in 1992. This was an overall decline of 76.8% from the 71,455 animals counted in 1975-79, of 11.0% from the 18,647 animals counted in 1989, and of 2.9% from the 17,080 animals counted at these sites in 1991 (Table 3). The annual rates of change, estimated by linear regression, were highly significant from 1975-79 to 1992 (9.8%; $r = 0.978$, $P < 0.001$) and marginally significant from 1989 to 1992 (4.4%; $r = 0.933$, $P = 0.067$).

In each of four regions, trends at rookeries were similar to those at all trend sites over the same time periods (Fig. 3B,

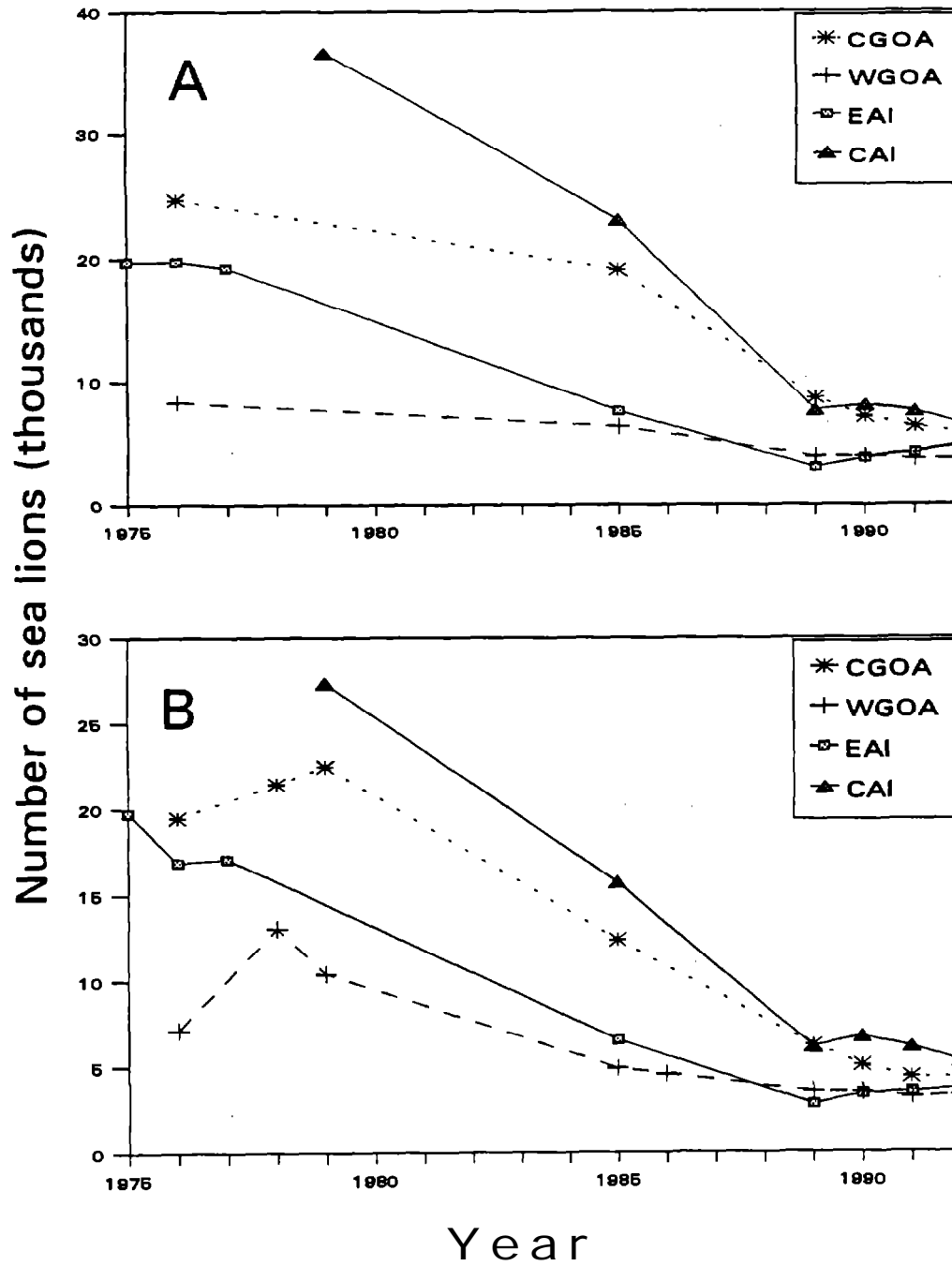


Figure 3.--Numbers of adult and juvenile Seller sea lions counted on trend rookeries and haul-out sites (A) and on trend rookeries (B) in the Kenai to Kiska area by region, 1975 to 1992: central (CGOA) and western (WGOA) Gulf of Alaska; eastern (EAI) and central (CAI) Aleutian Islands.

Table 5). Declines from the mid-1970s to 1992 ranged from 53.5% in the western Gulf of Alaska to 80.8% in the central Aleutian Islands. From 1989 to 1992, the number of animals counted declined in the central Gulf of Alaska (30.6%), in the western Gulf of Alaska (5.9%), and in the central Aleutian Islands (13.9%) but increased in the eastern Aleutian Islands (32.0%). From 1991 to 1992, numbers of sea lions in the central Aleutian Islands continued to decline (13.7%) but the other regions changed by about 5% (200 animals) or less.

Individual rookeries generally followed the pattern of the region in which they are located. Not surprisingly, the group of rookeries with the greatest proportional increases was in the eastern Aleutian Islands (Table 6). Three of the seven rookeries there increased by about 10% or more (Sea Lion Rocks, Akun Island, and Akutan) and two remained relatively unchanged (Bogoslof and Ogchul). The two rookeries that declined by 10% or more from 1991 to 1992 (Ugamak/Round and Adugak) were among the rookeries with the greatest increases (13%) over the previous year (e.g., from 1990 to 1991).

Outside of the eastern Aleutian Islands, the only rookery that increased by more than 10% in the Kenai to Kiska area was Atkins Island (+29%). Overall, changes at rookeries in the Kenai to Kiska area and elsewhere in Alaska were quite variable, both in direction and magnitude. In some cases, rookeries with the greatest increases from 1991 to 1992 showed substantial declines from 1991 to 1992: Chernabura Island (+47% from 1990 to 1991 and

-29% from 1991 to 1992), Adak Island (+25% and -28%), and Amchitka/Column Rocks (+18% and -17%).

Of all sea lions counted on trend sites in the Kenai to Kiska area in 1992, 80.2% were on rookeries (Fig. 4A, Table 7). Since the 1970s, this proportion has consistently been about 80%, except in 1985 when it dropped to 71.0%. The most noticeable trend in any region is the substantial and steady decline in the proportion of animals on rookeries in the eastern Aleutian Islands from 1989 through 1992 (Fig. 4A, Table 7).

Subareas Outside of the Kenai to Kiska Area

In 1992, we surveyed rookery and haul-out trend sites in three regions outside of the Kenai to Kiska area: Southeast Alaska, the eastern Gulf of Alaska, and the western Aleutian Islands (Fig 1., Table 2). The general trend in Southeast Alaska has been a steady increase in abundance from 1979 through 1989, followed by declines of 10.8% from 1989 to 1992 and 2.0% from 1991 to 1992 (Fig. 5A, Table 4). The trends for Southeast Alaska rookeries as a whole have been similar, except that the total count for trend rookeries increased slightly from 1991 to 1992 (Fig. 5B, Table 5) while the count for all trend sites decreased. From 1991 to 1992, the number of adults and juveniles remained relatively constant at White Sisters Islands, declined by 3.8% at Forrester Island, but increased by 23.3% at Hazy Islands (Table 6).

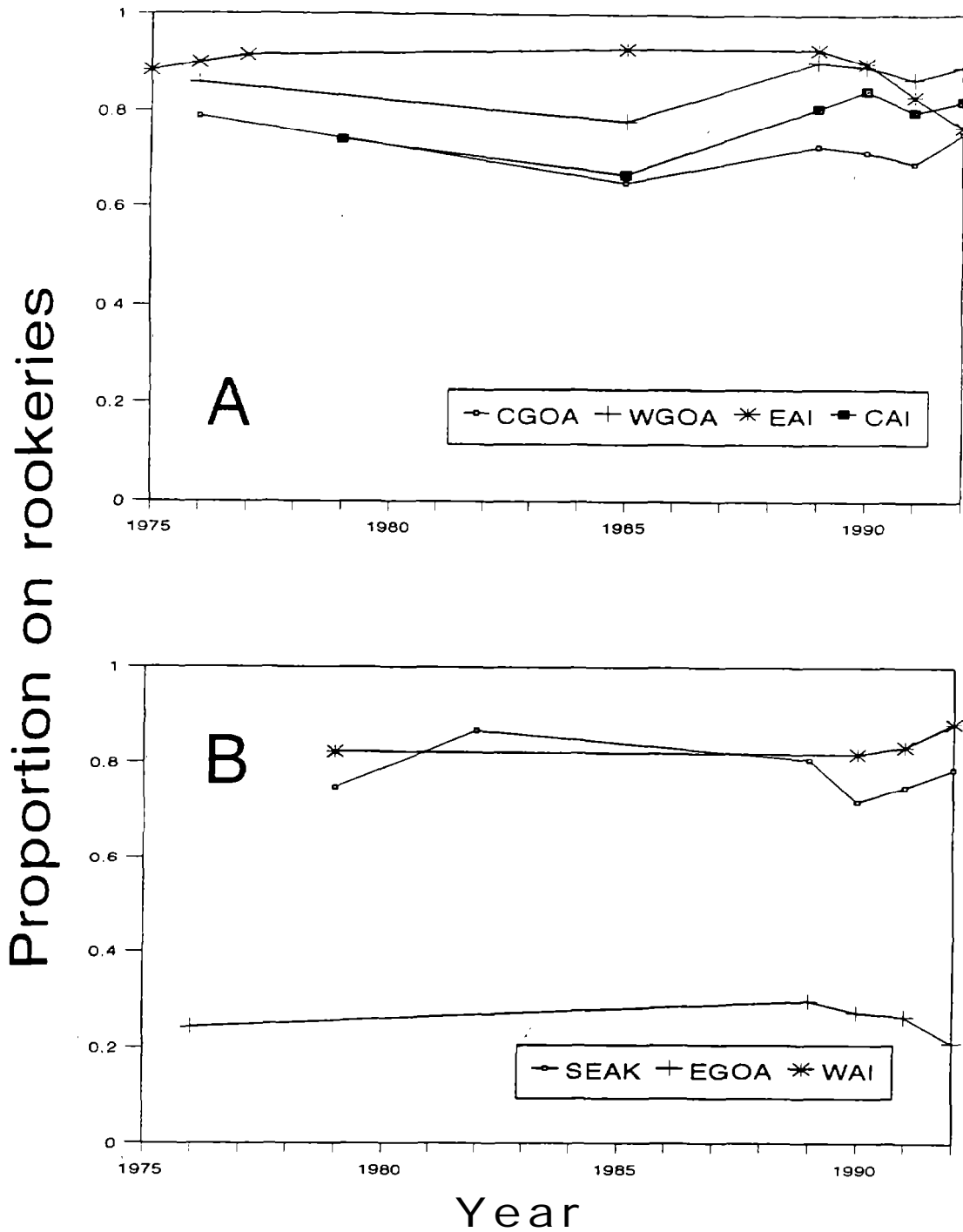


Figure 4. --Proportion of adult and juvenile Steller sea lions counted on rookery trend sites, by region, in the Kenai to Kiska area (A: central (CGOA) and western (WGOA) Gulf of Alaska and eastern (EAI) and central (CAI) Aleutian Islands) and elsewhere in Alaska (B: Southeast Alaska (SEAK), eastern Gulf of Alaska (EGOA), and western Aleutian Islands (WAI)).

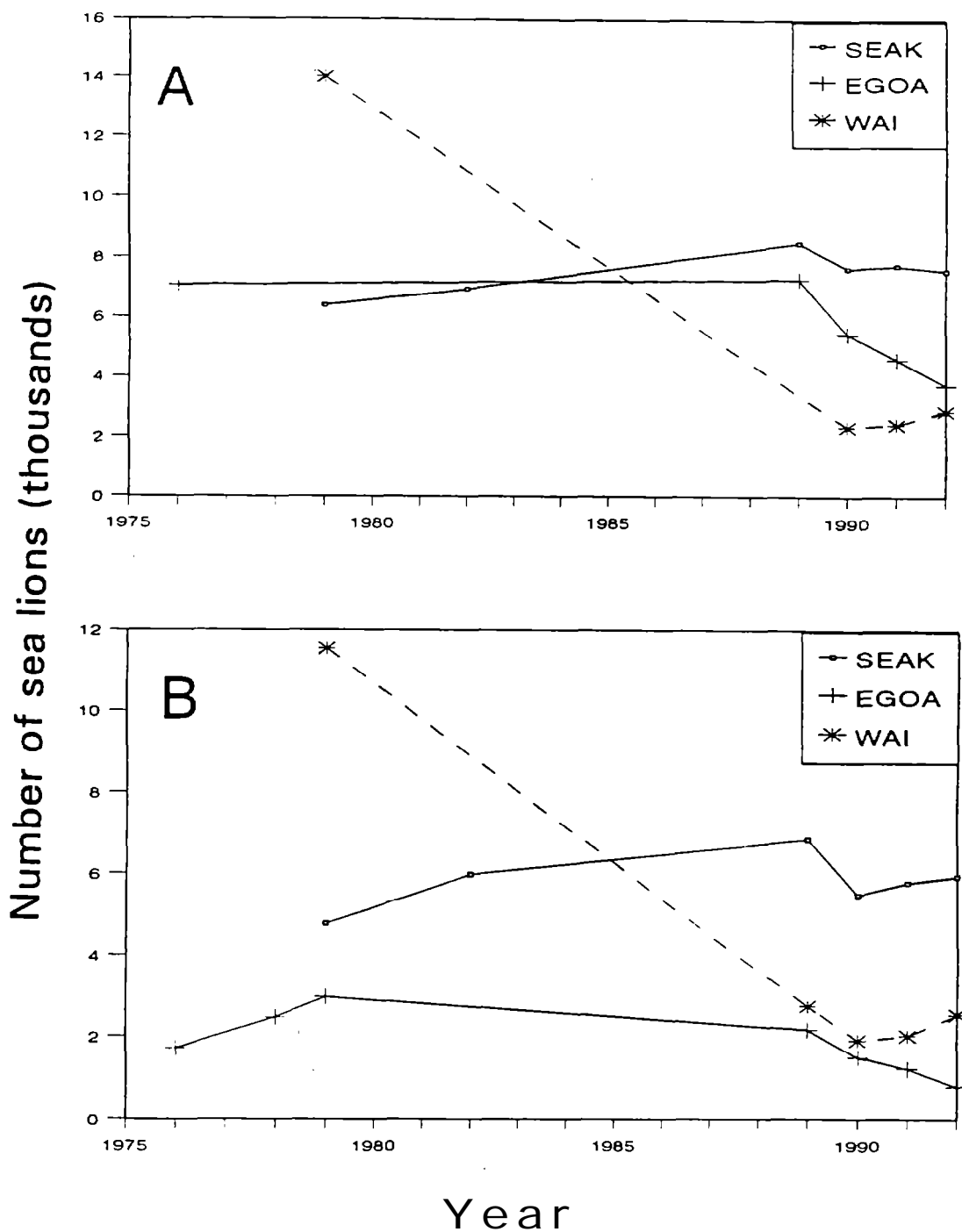


Figure 5. --Numbers of adult and juvenile Steller sea lions counted on trend rookeries and haul-out sites (A) and on trend rookeries (B) in regions outside the Kenai to Kiska area, 1976 to 1992: Southeast Alaska (SEAK), eastern Gulf of Alaska (EGOA), and western Aleutian Islands (WAI).

The number of sea lions in the eastern Gulf of Alaska changed little from 1976 to 1989, but they have declined each year since then (Fig. 5A, Table 4). The decline from 1991 to 1992 was 18.7%. The pattern was somewhat different at Seal Rocks, the only rookery in the eastern Gulf of Alaska, where the number of sea lions counted increased from 1976 through 1979, then decreased from 1979 to 1992 (Fig. 5B, Table 5). The decline from 1991 to 1992 at Seal Rocks was -35.7%.

After a precipitous decline from 1979 to 1990, numbers of sea lions counted in the western Aleutian Islands increased by 23.3% from 1990 to 1992 and 19.0% from 1991 to 1992 (Fig. 5A, Table 4). Trends for rookeries in the western Aleutian Islands were almost identical (Fig. 5B, Table 5). Increases were 32.7% from 1990 to 1992 and 25.7% from 1991 to 1992.

Of adult and juvenile sea-lions counted on trend sites, the proportion on rookeries has been consistently lower in the eastern Gulf of Alaska (20-30%) than in all other regions (about 65-90%) (Fig. 4B, Table 7). The proportion of animals counted on the eastern Gulf's only rookery declined steadily from 1989 through 1992. The proportion of animals on rookeries in Southeast Alaska and in the western Aleutian Islands has increased steadily from 1990 through 1992.

Pup Surveys

We counted 2,951 live pups at six rookeries in 1992 (Table 2). Of the six rookeries, four were counted last in 1990. The

number of pups increased at three of these: Akutan-Cape Morgan (+25.8%; 442 to 556), Chernabura (+8.8%; 193 to 210), and Chowiet (+9.1%; 582 to 635). The number of pups declined sharply at Sugarloaf Island from 1990 to 1992 (-46.6%; 1,874 to 1,001). Clubbing Rocks was last counted in 1984; the number of pups has declined substantially since then (-68.9%; 1,394 to 433). The new rookery at White Sisters Islands was counted in 1990, 1991, and 1992; the number of pups has increased each year (30+, 95, and 116, respectively).

Counts for 1989-90 and 1991-92 are available for 15 of the rookeries listed in Table 8. Seven rookeries showed increases in pup numbers greater than 10%, three experienced declines in excess of 10%, and five changed by less than 10%. The fastest growing rookeries were at White Sisters Islands (+253.3%; 30+ to 106) and at Hazy Island (+63.6%; 494 to 808), both in Southeast Alaska. The largest declines were at Outer Island (-60.9%; 460 to 180) and at Sugarloaf Island (-46.6%; 1,874 to 1,001), both in the central Gulf of Alaska. Regionally, the number of pups increased in Southeast Alaska (+24.2%; 3,362 to 4,175), in the eastern Gulf of Alaska (+16.9%; 562 to 657), at the two rookeries surveyed in both time periods in the western Gulf of Alaska (+13.9%), and in the eastern Aleutian Islands (+9.3%; 1,766 to 1,931) but declined in the central Gulf of Alaska (-29.3%; 5,773 to 4,083). Overall the number of pups declined (-4.4%; 12,091 to 11,561) from 1989-90 to 1991-92.

DISCUSSION

The 1992 aerial and ship-based surveys confirm the general conclusions of the previous surveys (Merrick et al. 1987, Loughlin et al. 1990, Merrick et al. 1991, Merrick et al. 1992). The number of Weller sea lions counted in the Gulf of Alaska and Aleutian Islands declined significantly from the mid-1970s through about 1989, at which time the rate of change may have moderated. The decline appears to be continuing, however, as the number of sea lions in Alaska decreased from 1991 to 1992 by another 1% to 5%, depending on whether only trend rookeries or all trend sites are considered. This decline was equally apparent in Alaska state-wide and in the Kenai to Kiska area.

Despite the overall decline in the Kenai to Kiska area and in Alaska statewide, the number of sea lions actually increased each year in the eastern Aleutian Islands since 1989, and in the western Aleutian Islands since 1990. This is somewhat encouraging, as the decline since the mid-1970s has been greatest in the Aleutian Islands. The magnitude of these recent gains, however, is rather small in comparison with the overall declines and as a proportion of the total population. The number of sea lions counted in the central Aleutian Islands region continued to decline at a significant rate. Similarly, indications that a decline may have moderated in the western Gulf of Alaska are outweighed by continued annual declines in the central and

eastern Gulf. The number of sea lions counted in Southeast Alaska generally has been stable.

Merrick et al. (1992) speculated that increases in the number and proportion of animals at haul-out sites could be interpreted as an early sign of recovery. One hypothesis currently under investigation is that a decline in juvenile survival may be a major contributing factor in the overall decline in sea lion numbers. Accordingly, declines in haul-out site populations observed during 1985-89 could have been the result of increased juvenile mortality. Increased counts of sea lions on haul-out sites (e.g., in the eastern Aleutian Islands), where many juveniles occur in summer, could indicate increased abundance of juveniles, presumably through increased juvenile survival. Recent survey results from some regions are compatible with this hypothesis (e.g., the eastern Aleutian Islands), while those from other regions are not (e.g., the western Aleutian Islands). Although the exact significance of the proportion of animals on rookeries is not yet clear, it appears that substantial and parallel increases occurred between 1985 and 1989 in three regions of the Kenai to Kiska area: the central and western Gulf of Alaska and the central Aleutian Islands (Fig. 4A).

Differences between survey results from different years could be confounded by the timing of surveys. The number of animals on shore at rookeries increases during June (Withrow 1982, Merrick et al. 1987). Thus, on an earlier survey date,

there may be fewer animals at a given site than on a later date (Merrick et al. 1992). For example, the western Gulf of Alaska and parts of the central Aleutian Islands were surveyed 1 to 2 weeks earlier in 1991 than in 1990. The earlier survey date in 1991 may have contributed to the declines observed in the western Gulf of Alaska and central Aleutian Islands between 1990 and 1991.

Replicate surveys in 1992 complicate analysis of the effect that survey dates may have on counts. During the 1992 survey in the eastern Gulf of Alaska, some counts were made on dates similar to those in 1991 and others were made 1 to 2 weeks earlier. Earlier dates may have contributed to the observed decline (18.7%) at the eastern Gulf trend sites from 1991 to 1992. In the central and western Gulf of Alaska, the 1992 counts were made 1 to 2 weeks later than in 1991. Counts at trend rookeries in the western Gulf increased slightly (+2.4%) from 1991 to 1992, although counts at all trend sites remained essentially unchanged. The number of animals counted in the central Gulf continued to decline in 1992. The effect of late counts in the central Gulf could be to reduce the apparent magnitude of a decline. Clearly, full analysis of the replicate surveys is needed to assess the affects of survey timing.

The most noteworthy trend in pup counts is the apparent decline in the central Gulf of Alaska, where pup production declined substantially (29.3%) from 1989-90 to 1991-92. Increases in Southeast Alaska (+24.2%), the eastern (+16.9%) and

western (+13.9%) Gulf of Alaska, and the eastern Aleutian Islands (+9.3%) were not sufficient to balance the decline in the central Gulf. The overall change in pup counts from 1989-90 to 1991-92 was a decline (-4.4%; 12,091 to 11,561). This was the same rate as that for all non-pups (adults and juveniles) counted at all trend sites in Alaska.

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Table 1. --Steller sea lion aerial survey schedule in Southeast Alaska, the Gulf of Alaska, and the Aleutian Islands, June and July 1992.

Date	Departure	Destination	Areas surveyed
<u>Aleutian Islands survey, National Marine Fisheries Service</u>			
6/10	Dutch Hbr.	Dutch Hbr.	Krenitzen Islands
6/11	Dutch Hbr.	Dutch Hbr.	Bogoslof, Umnak, Ogchul, Vsevidof, Yunaska Islands, Islands of Four Mountains
6/12	Dutch Hbr.	Adak	Seguam, Amlia, Atka, Kasatochi Islands
6/14	Adak	Adak	Adak and Delarof Islands
6/15	Adak	Shemya	Amchitka, Rat, Buldir, and Near Islands
6/16	Shemya	Adak	Amchitka, Amatignak, Adak Islands
	Adak	Dutch Hbr.	Oglodak, Salt, Atka Islands
6/17	Dutch Hbr.	Cold Bay	Krenitzen Islands, Unimak and Sanak Islands, Sandman Reef
	Cold Bay	Dutch Hbr.	Eastern Aleutian Islands
6/18	Dutch Hbr.	Dutch Hbr.	Unalaska and Umnak Islands, Islands of Four Mountains
6/19	Dutch Hbr.	Adak	Chagulak, Amukta, Amila, and Atka Islands
6/20	Adak	Amchitka	Adak, Delarof Islands, and Rat Islands
	Amchitka	Adak	Delarof Islands, Rat Islands, Semisopchnoi, Tanaga, Kanaga, and Bobrof Islands

Table 1. --Continued.

Date	Departure	Destination	Areas surveyed
6/25	Adak	Amchitka	Near Islands
	Amchitka	Shemya	Near Islands
6/26	Shemya	Adak	Adak, Seguam, Bogoslof Islands
	Adak	Dutch Hbr.	Amlia, Tanadak, Agligadak, Seguam, and Bogoslof Islands

Gulf of Alaska survey, National Marine Fisheries Service.

6/17	Anchorage	Kodiak	Kenai Peninsula, Barren Islands, Kodiak Archipelago
6/18	Kodiak	Kodiak	Kodiak Archipelago, Chirikof and Chowiet Islands
6/19	Kodiak	Cold Bay	Alaska Peninsula, Shumagin Islands, Sandman Reef
6/20	Cold Bay	Kodiak	Eastern Aleutian Islands
6/21	Kodiak	Kodiak	Kodiak Archipelago, Alaska Peninsula
6/23	Kodiak	Kodiak	Kenai Peninsula, Barren Islands, Kodiak Archipelago
6/24	Kodiak	Kodiak	Kodiak Archipelago, Chirikof and Chowiet Islands
6/25	Kodiak	Kodiak	Alaska Peninsula
6/28	Kodiak	Dutch Hbr.	Alaska Peninsula, Sandman Reef, Shumagin Islands, Eastern Aleutian Islands
6/29	Dutch Hbr.	Kodiak	Eastern Aleutian Islands

Table 1. --Continued.

Date	Departure	Destination	Areas surveyed
<u>Southeast Alaska survey, Alaska Department of Fish and Game.</u>			
6/10			Southeast Alaska
6/11			Southeast Alaska
6/12			Southeast Alaska
7/05			Southeast Alaska
<u>Eastern Gulf of Alaska survey, Alaska Department of Fish and Game.</u>			
6/10			Eastern Gulf of Alaska, Kenai Peninsula, and Barren Islands
6/11			Eastern Gulf of Alaska and Kenai Peninsula
6/13			Eastern Gulf of Alaska and Kenai Peninsula
6/14			Eastern Gulf of Alaska and Kenai Peninsula
6/15			Kenai Peninsula and Barren Islands
6/23			Eastern Gulf of Alaska and Kenai Peninsula
6/26			Eastern Gulf of Alaska and Kenai Peninsula

Table 2. --Counts of Steller sea lions at rookery (*) and haul-out locations in Alaska during June and July 1991. Trend sites (+) are those sites used for analyses of trends in survey counts.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
<u>Southeast Alaska</u>					
Gran/Ledge Point	6/10	P	280		
Wolf Rock	7/05	P	21		
Pinta Rocks	6/10,7/05	V	0		
Stevens Pass	6/10	V	0		
The Sisters	6/10	V	0		
Inian	6/10	V	5		
St. Lazaria	6/10,12	V	0		
Sunset	6/10	V	0		
Sea Lion+	6/10,12	V	6		
Cape Cross+	6/10,12	P	211		
Lull Point	6/10,7/05	V	7		
Tenakee Cannery Point	6/10	V	0		
Biorka	6/11,12,7/05	P	42		
Forrester+*	7/05	P	3,508		
Turnabout+	6/10,7/05	V	1		
Jacob Rock+	6/11,12,7/05	P	141		
Biali Rock+	6/11,12,7/05	P	439		
Coronation+	6/11,12,7/05	P	339		
Grindle	6/11	V	0		
Cape Addington	7/05	P	907		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Timbered	6/11,12,7/05	P	154		
Hazy+*	6/11,7/05	P	1,576		
Cape Omaney	6/11,12,7/05	P	723		
Yasha	6/10,7/05	V	0		
Round Rock	6/10,7/05	V	0		
The Brothers+	6/10,7/05	V	0		
White Sisters+*	6/10,12	P	861	6/26	116
Benjamin	6/10	V	81		
Cape Bingham	6/10,12	V	0		
Graves Rock+	6/10,12	P	366		
Cape Fairweather+	6/10	V	0		
South Marble	6/10	V	0		
Venisa Point	6/10	V	0		
Sail	7/05	P	170		
Taku Point	6/10	V	0		
Circle Point	6/10	V	0		
Horn Cliff	6/11	V	0		
Cape Bartolome	7/05	P	55		
Harbor Point+	6/10	P	110		
Subtotals - Southeast Alaska					
All 39 sites			10,003		116
13 rookery and haul-out trend sites			7,558		
3 rookery trend sites			5,945		

Table 2. --Continued.

Location	Adult and juvenile count			PUP count	
	Date(s)	Type ¹	Count	Date	Count
<u>Eastern Gulf of Alaska</u>					
Sitkagi Bluffs+	6/11,23	V	0		
Cape St. Elias+	6/10,11,13, 14,23	P	895		
Middleton	6/10,26	V	9		
Hook	6/11,13,14, 23,26	P	366		
Cape Hinchbrook	6/10,11,13, 14,23,26	P	129		
Seal Rocks+*	6/10,11,13, 14,23,26	P	784		
Fish (Wooded)+	6/10,11,13, 14,23	P	1,005		
Pleiades	6/10,26	V	3		
Glacier+	6/10,26	P	82		
Perry	6/26	V	0		
Point Eleanor	6/10,26	V	0		
The Needle+	6/10,11,13, 14,23,26	P	242		
Point Elrington+	6/10,11,14, 23,26	P	332		
Cape Puget	6/10,11,14 23,26	V	8		
Cape Junken	6/10,11,14, 23,26	V	0		
Cape Fairfield	6/10,11,13, 14,23,26	P	104		
Cape Resurrection	6/10,11,13, 114,23,26	V	0		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Aialik Cape	6/10,11,13 14,23,26	V	3		
Rugged+	6/10,11,13, 14,23,26	P	153		
Chiswell+	6/10,11,13, 14,15,23,26	P	240		
Seal Rock+	6/10,11,13 14,15,23,26	P	5		
Subtotals - Eastern Gulf of Alaska					
All 21 sites			4,360		
10 rookery and haul-out trend sites			3,738		
1 rookery trend site			784		
<u>Central Gulf of Alaska</u>					
Outer*	6/17	P	243		
Gore Point	6/23	P	4		
E. Chugach	6/23	P	3		
Perl	6/23	P	188		
Perl Rocks	6/23	P	2		
Nagahut Rocks	6/23	V	0		
Cape Elizabeth	6/23	P	102		
Sugarloaf+*	6/17,23	P	1,184	7/02	1,001
Sud	6/23	V	0		
Rocks south of Ushagat+	6/17,23	P	33		
Ushagat+ ²	6/17,23	P	227		
W. Amatuli	6/23	V	0		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
North Kodiak Island					
Latax Rocks+	6/17,23	P	193		
Sea Otter	6/23	V	0		
Tonki Cape	6/23	P	1		
Sea Lion Rocks+	6/17,23	P	57		
Marmot+*	6/17,23	P	1,581		
Eastern Kodiak Island					
Long+	6/18,23	P	114		
Cape Chiniak+	6/18,24	P	154		
Ugak	6/18,24	V	15		
Gull Point	6/24	P	46		
Cape Barnabas+	6/18,24	V	1		
Two-headed+	6/18,24	P	330		
Sundstrom	6/24	V	0		
Cape Sitkinak+	6/18,24	P	173		
Tugidak	6/18,24	V	0		
Chirikof+*	6/18,24	P	770		
Nagai Rocks	6/24	P	362		
Chowiet+*	6/18,24	P	771	7/04	635
Sutwik+	6/19,24	P	115		
Ugauishik+	6/19,24	P	18		
Western Kodiak Island					
Cape Alitak	6/24	V	0		
Cape Ikolik	6/21	P	64		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>			<u>PUP count</u>	
	Date(s)	Type ¹	Count	Date	Count
Western Kodiak Island (continued)					
Cape Sturgeon	6/21	V	0		
Cape Ugat	6/21	P	110		
Noisy	6/21	V	0		
Malina Point	6/21	V	0		
Steep Cape	6/21	V	0		
Cape Paramanof	6/21	V	0		
Cape Douglas	6/21	V	0		
Shakun Rocks	6/21	P	191		
Cape Nukshak	6/21	V	0		
Cape Ugiak	6/21	V	0		
Cape Gull	6/21	V	0		
Cape Kuliak	6/21	V	0		
Takli area	6/21	V	0		
Puale Bay	6/21	P	278		
Subtotals - Central Gulf of Alaska					
All 47 sites					
15 rookery and haul-out trend sites					
4 rookery trend sites					
<u>Western Gulf of Alaska</u>					
Lighthouse Rock	6/24	P	97		
Atkulik	6/24	V	0		
Kak	6/24	P	132		
Seal Cape	6/24	V	0		
Mitrofanania	6/28	P	112		

Table 2. --Continued.

Location	Adult and juvenile count			PUP count	
	Date(s)	Type ¹	Count	Date	Count
Spitz+	6/19,28	P	3		
Kupreanof Point	6/28	P	24		
Haystacks	6/28	V	0		
Hogue Rock	6/17,28	V	3		
Unga, Achereden Point	6/28	P	41		
Whaleback	6/28	P	395		
Castle Rock+	6/19,28	P	89		
Atkins+*	6/19,28	P	792		
Chernabura+*	6/19,28	P	459	7/16	210
Twins	6/28	V	0		
Nagai Island+	6/19,28	P	5		
Sea Lion Rocks+	6/19,28	P	149		
Cape Unga	6/28	V	0		
Jude	6/28	P	352		
Wosenoski	6/28	V	0		
Pinnacle Rock+*	6/17,19,28	P	1,092		
Rocks north of Pinnacle no.1	6/28	P	153		
Rocks north of Pinnacle no.2	6/28	P	230		
Clubbing Rocks+*	6/17,19,28	P	970	7/15	433
Cherni	6/17,28	V	0		
South Rock	6/17,28	P	232		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Bird+	6/17,20,28	P	161		
Rock	6/17,28	P	11		
Caton	6/28	V	0		
Subtotals - Western Gulf of Alaska					
All 29 sites			5,502		643
9 rookery and haul-out trend sites			3,720		
4 rookery trend sites			3,313		
<u>Eastern Aleutian Islands</u>					
Amak+ ²	6/17,20,28	P	869		
Sea Lion Rocks+*	6/17,20,28	P	329		
Unimak					
Cave Point	6/17	V	1		
Cape Lasaref	6/28	V	0		
Cape Lutke	6/17	V	0		
Oksenof Pt.	6/17	V	0		
Scotch Cap	6/17,28	V	0		
Cape Serichef	6/17,28	P	69		
Akutan					
Reef Point/ Lava Bight+	6/10,17,20,29	V	88		
North Cape	6/17	V	1		
Battery Point	6/17,29	V	0		
Cape Morgan+*	6/10,17,20,29	P	1,061	7,07	556
Akun					
Akun Head	6/29	V	0		
Billings Head+*	6/10,17,20,29	P	271		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Akun (continued)					
Jackass Point	6/29	V	0		
Tanginak	6/17,29	P	42		
Tigalda	6/17,20,29	P	205		
South side	6/10	V	25		
Basalt Rock	6/17	V	3		
Kaligigan	6/29	V	1		
Ugamak and Round Island+**	6/10,17,20,29	P	954		
Aiktak	6/17,29	P	63		
Rootok	6/17,29	P	70		
Baby Islands	6/29	P	139		
Old Man Rocks	6/17	P	148		
Egg	6/17	V	0		
Unalaska					
Cape Izigan	6/18	V	0		
Spray Cape	6/18	P	18		
Makushin Bay	6/18	P	48		
Bishop Point	6/18	P	105		
Cape Wislow	6/18	V	0		
Inner Signal	6/17	V	0		
Outer Signal	6/17	P	53		
Emerald Isle	6/18	V	0		
Polivnoi Rock	6/18	P	24		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Pillars	6/18	V	0		
Ogchul+*	6/11,18	P	235		
Vsevidof+	6/11,18	P	94		
Samalga	6/18	V	0		
Adugak+*	6/11,18	P	322		
Umnak					
Cape Aslik+	6/11,18	P	76		
Cape Idak	6/16	V	0		
Bogoslof+*	6/11,18,26	P	540		
Subtotals - Eastern Aleutian Islands					
All 43 sites			5,854		556
11 rookery and haul-out trend sites			4,839		
7 rookery trend sites			3,712		
<u>Central Aleutian Islands</u>					
Chuginadak+	6/11,18	P	120		
Herbert+	6/11,18	V	5		
Kagamil+	6/11,18	P	9		
Uliaga	6/18	P	54		
Carlisle+	6/11,18	V	14		
Yunaska+*	6/11,18	P	393		
Chagulak+	6/12,18	P	50		
Amukta+	6/12,19	P	42		
Seguam					
Saddleridge+*	6/12,26	P	696		
Other+	6/12,26	P/V	125		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Amlia					
Sviechnikof*	6/21	P	103		
East Cape+	6/26	V	6		
Cape Misty	6/12,19	V	0		
Sagigik+	6/21	P	58		
Tanadak+	6/12,26	V	10		
Agligadak+*	6/12,26	P	141		
Atka					
North Cape+	6/12,19	P	118		
Cape Korovin+	6/16,19	V	1		
Salt+	6/16,19	V	0		
Great Sitkin	6/16	V	3		
Anagaksik+	6/14,19	V/P	38		
Fenimore	6/16,19	V	4		
Ikiginak+	6/16,19	V	0		
Oglodak	6/16,19	P	77		
Kasatochi+*	6/12,19	P	376		
Koniuji	6/19	V	3		
Kagalaska	6/19	P	68		
Little Tanaga+	6/14,19	P	51		
Adak					
Cape Yakak/Lake Point+* ²	6/14,20	P	614		
Argonne Point/ Cape Moffet+ ²	6/16,26	V	0		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Adak (continued)					
Crane I.	6/20	V	10		
Kanaga					
North Cape	6/20	P	25		
Ship Rock	6/20	P	93		
Bobrof	6/20	V	150		
Tanaga					
Bumpy Point	6/20	V	42		
Cape Sasmik	6/20	P	65		
Gramp Rock+*	6/14,20	P	691		
Ugidak+	6/14,20	V/P	48		
Tag+*	6/14,20	P	370		
Kavalga+	6/14,20	P	34		
Unalga and Dinkum Rocks+ ²	6/14,20	P	95		
Ulak/Hasgox Point+*	6/14,20	P	1,059		
Amatignak+ ²	6/16,20	P	153		
Gareloi	6/20	V	0		
Ilak	6/20	V	16		
Semisopochnoi*	6/20	P	373		
Amchitka					
East Cape+	6/15,20	P	162		
Cape St. Makarias	6/15,20	V	2		
Column Rocks*	6/15,25	P	194		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
Amchitka (continued)					
Ivakin Point+	6/15,20	V	2		
Bird Island	6/25	V	0		
Ayugadak+*	6/15,20	P	313		
Rat	6/15,25	V	80		
Sea Lion Rocks	6/15,20	V	5		
Tanadak (Kiska)	6/15,20	P	136		
Little Sitkin	6/20	P	135		
Segula	6/20	V	5		
Kiska					
Sobaka-Vega Pt.	6/20	V/P	138		
Cape St. Stephens+*	6/15,20	P	248		
Lief Cove+*	6/15,20	P	357		
Pillar Rock	6/20	V	13		
Sirius Point	6/20	P	114		
Subtotals - Central Aleutian Islands					
All 62 sites			8,307		
34 rookery and haul-out trend sites			6,399		
11 rookery trend sites			5,258		
<u>Western Aleutian Islands</u>					
Buldir+* ³	6/15,25	V/P	454		
Agattu+*	6/15,25	P	2,077		
Attu*	6/25	P	1,416		
Alaid+	6/15,25	P	338		

Table 2. --Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Nizki	6/25	V	0		
Shemya	6/25	P			
Subtotal - Western Aleutian Islands					
All 6 sites			4,533		
3 rookery and haul-out trend sites			2,869		
2 rookery trend sites			2,531		
<u>Totals for Kenai to Kiska</u>					
All 181 sites			26,993		2,835
69 rookery and haul-out trend sites			20,679		
26 rookery trend sites			16,589		
<u>Totals for all regions of Alaska</u>					
All 247 sites			45,889		2,951
95 rookery and haul-out trend sites			34,844		
32 rookery trend sites			25,849		

¹p = aerial photo count; V = aerial visual count.

²Includes two sites listed as trend sites in Merrick et al. 1992.

³Includes three sites listed as trend sites in Merrick et al. 1992.

Table 3. --Counts of adult and juvenile Steller sea lions observed at rookery and haul-out trend sites in the Kenai to Kiska area and Alaska statewide for June and July aerial surveys from 1976 to 1992, including coefficients of variation (CV) for the 1992 survey. Totals include only those sites counted in all surveys (Table 2). See text for a description of methods used to calculate annual rate of change and statistical significance¹.

Year	<u>Kenai to Kiska Area</u>		<u>All of Alaska</u>	
	Rookeries	All sites	Rookeries	All sites
1976	71,455 ²	89,364 ²		
1979			90,821 ²	116,804 ²
1985	39,634	55,824		
1989	18,647	23,064	30,388	
1990	18,694	22,754	27,563	38,154
1991	17,080	21,737	26,099	36,459
1992	16,589	20,679	25,849	34,844
<u>Overall change</u>				
1976/79-92	- 77%	- 77%	- 72%	- 70%
1989-92	- 11%	- 10%	- 15%	nd ³
<u>Annual rate of change</u>				
1976/79-92	- 10% ^{***}	- 10% ^{**}	- 10% ^{***}	- 10% ^{**}
1989-92	- 4% [*]	- 4% [*]	- 5% [*]	nd
1991-92	- 3%	- 5% [*]	- 1%	- 4% [*]
<u>CV</u>				
1992	2.12%	1.89%	2.11%	1.84%

¹Significance level: *** $P \leq 0.001$; .* $0.001 < P \leq 0.01$; . $0.01 < P \leq 0.1$.

²sum of regional counts from 1975 through 1979.

³nd = no data.

Table 4.--Counts of adult and juvenile Steller sea lions observed at rookery and haul-out trend sites in seven subareas of Alaska during June and July aerial surveys **from from** 1975 to 1992, including coefficients of variation (CV) for the 1992 survey. Totals include only those sites counted in all surveys (Table 2). See text for a description of methods used to calculate overall percent change and coefficients of variation.

Year	Sources ¹	Southeast	Gulf of Alaska			Aleutian Islands		
		Alaska	Eastern	Central	Western	Eastern	Central	Western
1975	1					19,769		
1976	1,2		7,053	24,678	8,311	19,743		
1977	1					19,195		
1979	3,4,5	6,376					36,632	14,011
1982	3	6,898						
1985	6			19,002	6,275	7,505	23,042	
1989	3,7	8,471	7,241	8,552	3,908	3,032	7,572	
1990	3,5,8	7,629	5,444	7,050	3,915	3,801	7,988	2,327
1991	9	7,715	4,596	6,273	3,734	4,231	7,499	2,411
1992	10	7,558	3,738	5,721	3,720	4,839	6,399	2,869
Overall change								
	1975/79-92	+ 19%	- 47%	- 77%	- 55%	- 76%	- 83%	- 80%
	1989-92	- 11%	- 48%	- 33%	- 5%	+ 60%	- 15%	nd ²
	1991-92	- 2%	- 19%	- 9%	- 0.4%	+ 14%	- 15%	+ 19%
CV								
	1992	7.87%	4.03%	4.14%	2.50%	3.93%	3.58%	7.75%

¹Sources: 1. Braham et al. 1980; 2. Calkins and Pitcher 1982; 3. Alaska Department of Fish and Game unpubl. data; 4. Fiscus et al. 1981; 5. Douglas and Byrd 1991; 6. Loughlin et al. 1986; 7. Loughlin et al 1990; 8. Merrick et al. 1991; 9. Merrick et al. 1992; 10. This study.

²nd = no data.

Table 5. --Counts of adult and juvenile Steller sea lions at trend rookeries in seven subareas of Alaska during June and July aerial surveys from 1975 to 1991, including coefficients of variation (CV) for the 1992 survey. Totals include only those sites counted in all surveys (see Table 2). Some totals, especially for the Aleutian Islands during the 1980s, have been corrected since previous reports (e.g., Merrick et al. 1992). See text for a description of methods used to calculate overall percent change and coefficients of variation.

Year	Sources ¹	Southeast Alaska	Gulf of Alaska			Aleutian Islands		
			Eastern	Central	Western	Eastern	Central	Western
1976	1, 2		1,709	19,479	7,125	16,871		
1977	1					17,068		
1978	3		2,463	21,434	13,056			
1979	3, 4, 5	4,775	2,961	22,464	10,397		27,376	11,536
1982	3	5,979						
1985	6			12,379	4,888	6,534	15,717	
1986	6				4,540			
1989	3, 5, 7	6,844	2,159	6,207	3,521	2,813	6,106	2,738
1990	3, 5, 8	5,491	1,491	5,043	3,496	3,417	6,738	1,907
1991	9	5,786	1,220	4,337	3,235	3,519	6,095	2,013
1992	10	5,945	784	4,306	3,313	3,712	5,258	2,531
Overall change								
	1976/79-92	+ 25%	- 54%	- 78%	- 54%	- 78%	- 81%	- 78%
	1989-92	- 13%	- 64%	- 31%	- 6%	+ 32%	- 14%	- 8%
	1991-92	+ 3%	- 36%	- 0.7%	+ 2%	+ 5%	- 14%	+ 26%
CV								
	1992	12.02%	6.91% ²	4.45%	2.50%	5.04%	4.02%	4.10%

¹Sources: 1. Braham et al. 1980; 2. Calkins and Pitcher 1982; 3. Alaska Department of Fish and Game unpub. data; 4. Fiscus et al. 1981; 5. Douglas and Byrd 1991; 6. Loughlin et al. 1986; 7. Loughlin et al. 1990; 8. Merrick et al. 1991; 9. Merrick et al. 1992; 10. This study.

²CV for the eastern Gulf of Alaska is for only one rookery site - Seal Rocks.

Table 6. --Counts of Steller sea lions at principal rookeries in Southeast Alaska, the Gulf of Alaska, and the Aleutian Islands for 1976-79 through 1992, including overall percent change (1992) between each count year and the 1992 count. Data sources are the same as for Tables 4 and 5.

Rookery	1976-79 (Δ1992)	1985 (Δ1992)	1989 (Δ1992)	1990 (Δ1992)	1991 (Δ1992)	1992
<u>Southeast Alaska</u>						
Forrester	3,121 (+ 12%)	nd ¹ -	4,648 (- 25%)	3,324 (+ 6%)	3,648 (- 4%)	3,508
Hazy	893 (+ 76%)	1,251 (+ 26%)	1,462 (+ 8%)	1,187 (+ 33%)	1,278 (+ 23%)	1,576
White Sisters	761 (+ 13%)	1,144 (- 25%)	734 (+ 17%)	980 (- 12%)	860 (0%)	861
<u>Eastern Gulf of Alaska</u>						
Seal Rocks	2,961 (- 74%)	nd ¹ -	2,159 (- 64%)	1,471 (- 47%)	1,220 (- 36%)	784
<u>Central Gulf of Alaska</u>						
Outer	3,847 (- 94%)	nd ¹ -	350 (- 31%)	589 (- 59%)	334 (- 27%)	243
Sugarloaf	5,226 (- 77%)	2,991 (- 60%)	1,861 (- 36%)	1,319 (- 10%)	1,216 (- 3%)	1,184
Marmot	9,862 (- 84%)	4,983 (- 68%)	2,331 (- 32%)	1,766 (- 10%)	1,459 (+ 8%)	1,581
Chowiet	2,000 (- 61%)	2,059 (- 63%)	737 (0%)	897 (- 14%)	716 (+ 8%)	771
Chirikof	2,391 (- 68%)	2,346 (- 67%)	1,278 (- 40%)	1,061 (- 27%)	946 (- 19%)	770

Table 6. --Continued.

Rookery	1976-79 (Δ1992)	1985 (Δ1992)	1989 (Δ1992)	1990 (Δ1992)	1991 (Δ1992)	1992
<u>Western Gulf of Alaska</u>						
Atkins	2,726 (- 71%)	1,562 (- 49%)	755 (+ 5%)	728 (+ 9%)	616 (+ 29%)	792
Chernabura	1,437 (- 68%)	487 (- 6%)	544 (- 16%)	442 (+ 4%)	650 (- 29%)	459
Pinnacle Rock	1,745 (- 37%)	1,588 (- 31%)	1,366 (- 20%)	1,305 (- 16%)	1,049 (+ 4%)	1,092
Clubbing Rocks	1,217 (- 20%)	1,251 (- 22%)	856 (+ 13%)	1,021 (- 5%)	920 (+ 5%)	970
<u>Eastern Aleutian Islands</u>						
Sea Lion Rock	2,076 (- 84%)	538 (- 39%)	344 (- 4%)	286 (+ 15%)	300 (+ 10%)	329
Ugamak and Round I.	5,006 (- 81%)	1,503 (- 37%)	450 (+ 112%)	945 (+ 1%)	1,063 (- 10%)	954
Akun-Billings Bead	1,050 (- 74%)	435 (- 38%)	150 (+ 81%)	118 (+ 130%)	156 (+ 74%)	271
Akutan-Cape Morgan	3,145 (- 66%)	1,269 (- 16%)	578 (+ 84%)	765 (+ 39%)	818 (+ 30%)	1,061
Bogoslof	3,308 (- 84%)	1,287 (- 58%)	682 (- 21%)	713 (- 24%)	558 (- 3%)	540
Ogchul	1,109 (- 79%)	547 (- 57%)	217 (+ 8%)	240 (- 2%)	229 (+ 3%)	235
A dugak	1,177 (- 73%)	955 (- 66%)	392 (- 18%)	350 (- 8%)	395 (- 18%)	322

Table 6. --Continued.

Rookery	1976-79 (Δ1992)	1985 (Δ1992)	1989 (Δ1992)	1990 (Δ1992)	1991 (Δ1992)	1992
<u>Central Aleutian Islands</u>						
Yunaska	2,249 (- 83%)	1,071 (- 63%)	466 (- 16%)	391 (0%)	398 (- 1%)	393
Seguam-Saddleridge	6,493 (- 89%)	2,942 (- 76%)	602 (+ 16%)	833 (- 16%)	684 (+ 2%)	696
Agligadak	993 (- 86%)	514 (- 73%)	132 (+ 7%)	274 (- 49%)	231 (- 39%)	141
Kasatochi	2,166 (- 83%)	1,170 (- 68%)	659 (- 43%)	641 (- 41%)	466 (- 19%)	376
Adak-Lake Pt./C. Yakak	1,242 (- 51%)	1,289 (- 52%)	424 (+ 45%)	592 (+ 4%)	847 (- 28%)	614
Gramp Rock	1,705 (- 59%)	1,290 (- 46%)	747 (- 7%)	712 (- 3%)	773 (- 11%)	691
Tag	1,740 (- 79%)	944 (- 61%)	590 (- 37%)	478 (- 23%)	440 (- 16%)	370
Ulak-Hasgox Point	2,170 (- 51%)	2,729 (- 61%)	1,123 (- 6%)	1,324 (- 20%)	1,046 (+ 1%)	1,059
Amchitka-Column Rocks	1,943 (- 90%)	728 (- 73%)	nd ¹ -	197 (- 2%)	233 (- 17%)	194
Amchitka-East Cape	639 (- 75%)	1,005 (- 84%)	nd ¹ -	106 (+ 53%)	151 (+ 7%)	162
Ayugadak	1,463 (- 79%)	702 (- 55%)	389 (- 20%)	401 (- 22%)	324 (- 3%)	313

Table 6. --Continued.

Rookery	1976-79 (Δ1992)	1985 (Δ1992)	1989 (Δ1992)	1990 (Δ1992)	1991 (Δ1992)	1992
Semisopchnoi	1,223 (- 70%)	nd ¹ -	nd ¹ -	nd ¹ -	443 (- 16%)	373
Kiska-Lief Cove	4,953 (- 93%)	1,715 (- 79%)	510 (- 30%)	528 (- 32%)	506 (- 29%)	357
Kiska-St. Stephens	2,202 (- 89%)	1,351 (- 82%)	464 (- 47%)	564 (- 56%)	380 (- 35%)	248
<u>Western Aleutian Islands</u>						
Buldir	5,024 (- 91%)	nd ¹ -	1,058 (- 57%)	729 (- 38%)	589 (- 23%)	454
Agattu-Cape Sabak	6,512 (- 80%)	3,130 (- 58%)	1,680 (- 22%)	1,178 (- 11%)	1,429 (- 9%)	1,304
Agattu-Gillon Point	821 (- 6%)	nd ¹ -	806 (- 4%)	nd ¹ -	670 (+ 15%)	773
Attu-Cape Wrangell	3,310 (- 77%)	nd ¹ -	nd ¹ -	nd ¹ -	736 (- 3%)	755
<u>Trend Site Totals</u>						
Kenai-Kiska ² (from Table 3)	71,455 (- 77%)	39,634 (- 58%)	18,647 (- 11%)	18,694 (- 11%)	17,080 (- 3%)	16,589
Alaska ³ (from Table 3)	90,821 (- 72%)	- -	30,388 (- 15%)	27,563 (- 6%)	26,099 (- 1%)	25,849

¹nd = no data.

²Does not include Attu, Agattu, Buldir, Semisopchnoi, Amchitka, Outer, Seal Rocks, White Sisters, Hazy, and Forrester Islands.

³Excludes Attu, Semisopchnoi, Amchitka, and Outer Islands.

Table 7. --Proportion of adult and juvenile numbers counted on trend rookeries (compared to counts for all trend sites) in seven subareas of Alaska during June and July aerial surveys from 1975 to 1992. Only sites counted in all surveys are included (see Table 2).

Year	Southeast Alaska	Gulf of Alaska			Aleutian Islands		
		Eastern	Central	Western	Eastern	Central	Western
1975	-	-	-	-	0.882	-	-
1976	-	0.243	0.789	0.857	0.898	-	-
1977	-	-	-	-	0.914	-	-
1978	-	-	-	-	-	-	-
1979	0.748	-	-	-	-	0.740	0.823
1982	0.867	-	-	-	-	-	-
1985	-	-	0.651	0.779	0.929	0.668	-
1989	0.807	0.298	0.726	0.901	0.928	0.806	-
1990	0.719	0.274	0.715	0.892	0.899	0.843	0.819
1991	0.749	0.265	0.691	0.866	0.831	0.799	0.834
1992	0.787	0.210	0.753	0.891	0.767	0.822	0.882

Table 8. --Counts of Steller sea lion pups at selected rookeries in the Gulf of Alaska and Aleutian Islands during June and July surveys from 1984-85, 1989-90, and 1991-92, including the percent change (Δ 1991-92) from the earlier counts to the 1991-92 counts. Individual sites usually are counted on alternate years, thus two years are required for complete counts.

Area or island	1984-85 ¹ (Δ 1991-92)	1989-90 ² (Δ 1991-92)	1991-92 ³
Southeast Alaska			
White Sisters	nd ⁴ -	30+ +253%	106 ⁵
Hazy	nd ⁴ -	494 ⁶ + 64%	808
Forrester	2,568 + 27%	2,838 ⁶ + 15%	3,261
Eastern Gulf of Alaska			
Seal Rocks	nd ⁴ -	562 ⁶ + 17%	657
Central Gulf of Alaska			
Outer	933 ⁷ - 81%	460 ⁶ - 61%	180
Sugarloaf	3,114 - 68%	1,874 ⁶ - 47%	1,001
Marmot	5,751 - 72%	2,199 - 27%	1,611
Chowiet	3,207 - 80%	582 ⁶ + 9%	635
Chirikof	1,913 - 66%	658 ⁶ 0%	656
Western Gulf of Alaska			
Atkins	2,093 - 76%	435 + 16%	505
Chernabura	200 + 5%	193 + 9%	210

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