



NOAA Technical Memorandum NMFS-AFSC-71

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 1994

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J. M. Strick, L. W. Fritz, and J. P. Lewis

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

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During June and July 1994**

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ABSTRACT

Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) were conducted during June and July 1994 from Forrester Island in Southeast Alaska to Attu Island in the western Aleutian Islands. A total of 32,945 adults and juvenile Steller sea lions were counted at 95 trend rookery and haulout sites. This represents decreases of 5.5% from 1992 counts (34,844) and 13.7% from 1990 (38,154). Annual rates of change, as estimated by linear regression, were -2.8% from 1992 to 1994 ($P < 0.05$) and -3.7% from 1990 to 1994 ($P = 0.008$). In 1994, 23,452 adult and juvenile sea lions were counted on trend rookery sites throughout Alaska. This represents a decrease of 14.9% from 1990 counts (27,563) and a 9.3% decrease from 1992 counts (25,849). Estimated annual rates of change for 32 trend rookeries throughout Alaska were -3.9% ($P = 0.017$) for 1990-94 and -4.9% ($P < 0.005$) for 1992-94.

The area between the Kenai Peninsula and Kiska Island includes 69 trend rookery and haulout sites. Since 1990, adult Steller sea lions decreased 17.8% on these trend sites. Between 1992 and 1994, the number of adult Steller sea lions on trend sites decreased 9.5%. Annual rates of change of adult Steller sea lions on trend sites have been -4.9% ($P < 0.001$) for 1990-94, and -5.0% ($P < 0.001$) for 1992-94.

The 26 trend rookeries contained 14,505 sea lions in 1994. This represents a decrease of 22.4% from the 1990 count (18,694)

and a 12.6% decrease from the 1992 count. Annual rates of change were -7.1% ($P = 0.028$) for 1990-94, and -6.7% ($P < 0.001$) for 1992-94. Throughout Alaska the greatest decreases at trend rookery sites were seen in the central Gulf of Alaska (-28.0%; 4,306 in 1992 to 3,099 in 1994) and the western Aleutian Islands (-28.3%; 2,531 in 1992 to 1,815 in 1994). The smallest decreases were in the western Gulf of Alaska (-4.8%; 3,313 in 1992 to 3,155 in 1994) and the eastern Aleutian Islands (-5.3%; 3,712 in 1992 to 3,515 in 1994). The only increase occurred in Southeast Alaska, up 9.3% from the 1992 count (5,945 in 1992 to 6,496 in 1994).

A total of 13,850 live pups were counted at 33 rookeries from Southeast Alaska through the central Aleutian Islands in 1994; there were no pup counts conducted in the western Aleutian Islands during 1994. Since 1991-92, pup production has decreased at rookeries in all of the Alaska subareas: Southeast Alaska (-11.3%), eastern Gulf of Alaska (-11.4%), central Gulf of Alaska (-27.4%), western Gulf of Alaska (-8.0%), and eastern Aleutian Islands (-14.5%). The number of pups counted has decreased by 24% in the central Aleutian Islands since 1989-90. At Walrus Island (Bering Sea) a total of 61 pups were counted in 1994, compared to 63 pups counted there in 1992--a decrease of 3.1%.

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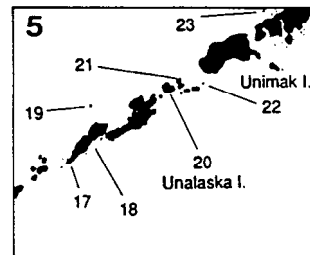
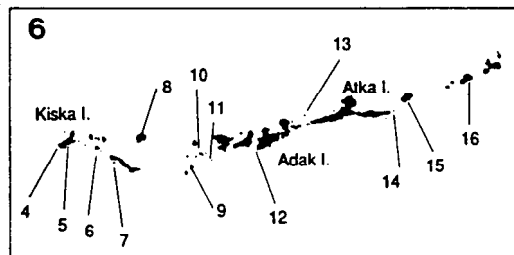
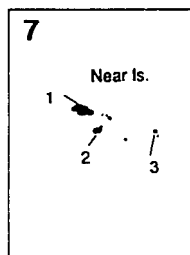
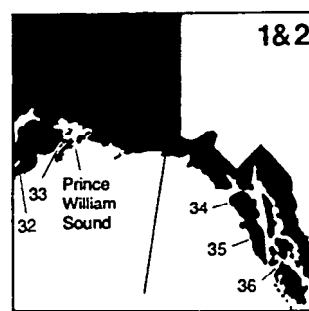
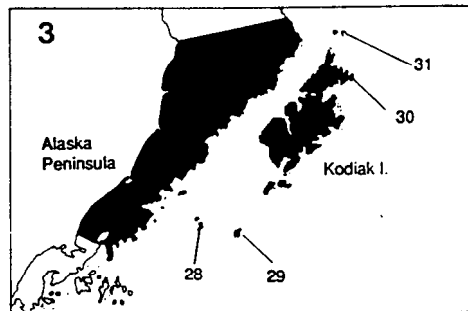
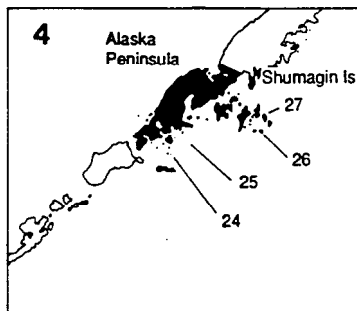
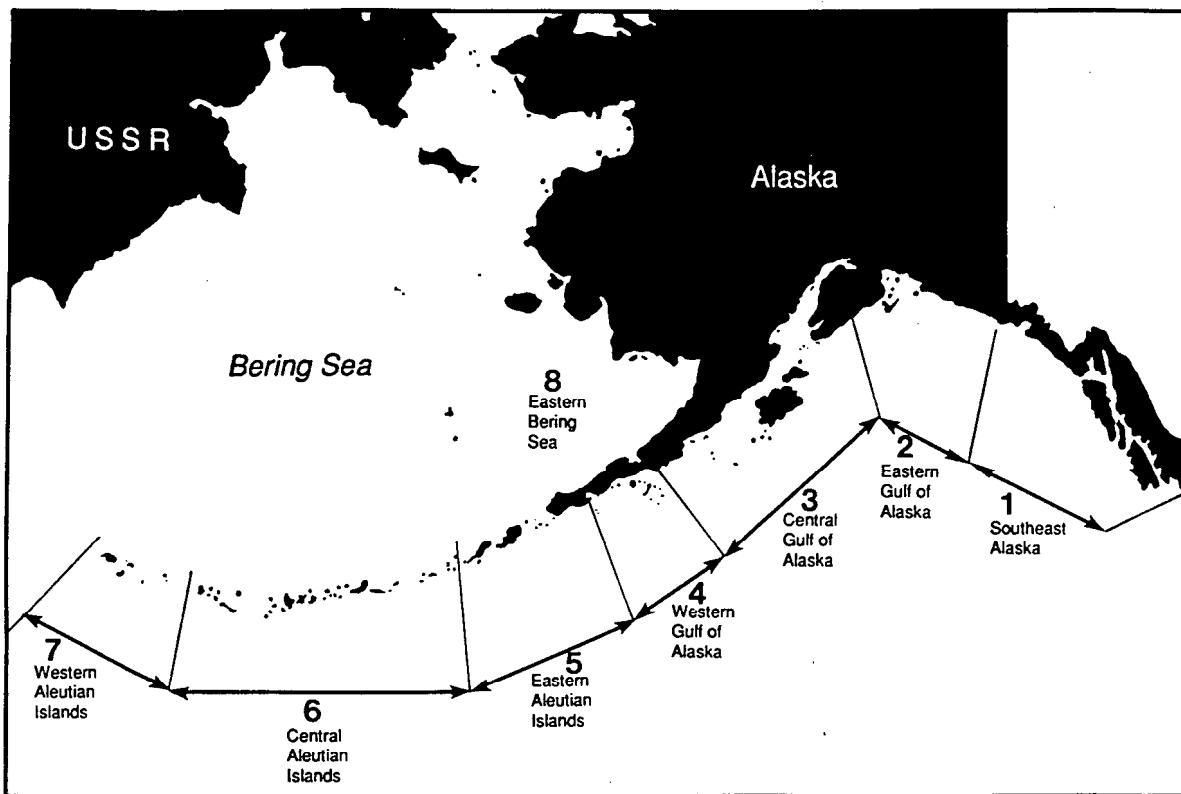
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INTRODUCTION

This report presents results from the 1994 aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) (adults, juveniles, and pups) from Southeast Alaska through the western Aleutian Islands (Fig. 1). A total of 271 rookeries and haulout sites were surveyed. Pups were counted at 33 rookeries from Forrester Island (Southeast Alaska) to Kiska Island (central Aleutian Islands).

This survey continues the series of aerial surveys conducted by the National Marine Mammal Laboratory (NMML) and the Alaska Department of Fish and Game (ADF&G) since the mid-1970s (Braham et al. 1980, Calkins and Pitcher 1982, Loughlin et al. 1984, Loughlin et al. 1986, Merrick et al. 1987, Loughlin et al. 1990, Merrick et al. 1991, Merrick et al. 1992, Sease et al. 1993, ADF&G¹). Because of the numerous potential sites that may be occupied by sea lions and the extent of the survey range, this report, like others in the recent series (Merrick et al. 1991, Merrick et al. 1992, Sease et al. 1993), only focuses on Steller sea lions inhabiting trend rookery and trend haulout sites. Analyses in this report concentrate on data from 1990 to 1994; in 1989, only the Kenai to Kiska segment of the aerial survey was flown and therefore is considered an incomplete survey.

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



- | | | | | | | |
|----------|-----------------|---------------|-------------|-------------------|--------------|------------------|
| 1 Attu | 4,5 Kiska | 11 Gramp Rock | 17 Adugak | 22 Ugamak | 27 Atkins | 33 Seal Rocks |
| 2 Agattu | 6 Ayugadak | 12 Adak | 18 Ogchul | 23 Sea Lion Rock | 28 Chowiet | 34 White Sisters |
| 3 Buldir | 7 Amchitka | 13 Kasatochi | 19 Bogoslof | 24 Clubbing Rocks | 29 Chirikof | 35 Hazy |
| | 8 Semisopochnoi | 14 Agligadak | 20 Akutan | 25 Pinnacle Rock | 30 Marmot | 36 Forrester |
| | 9 Ulak | 15 Seguam | 21 Akun | 26 Chernabura | 31 Sugarloaf | |
| | 10 Tag | 16 Yunaska | | | 32 Outer | |

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

For a more complete historical perspective on sea lion counts, see Merrick et al. 1991 (for 1956-90) or Sease et al. 1992 (for 1976-92). Unlike the 1992 survey, which included replicate aerial surveys, the 1994 aerial survey was a single survey. Only trend sites in the eastern and central Aleutian Islands were surveyed more than once. The 1994 survey also continued the systematic analysis of the number of Steller sea lion pups born in the area from Forrester Island in Southeast Alaska to Kiska Island in the central Aleutian Islands (Fig. 1).

METHODS

Analyses contained in this report focus on trend sites. Trend sites are major rookeries and haulout sites that have been counted consistently during recent surveys. Rookeries are those sites where adult males actively defend territories, pups are born, and mating takes place. Haulout sites are those where sea lions predictably rest on land (haulout), but where few or no pups are born (Calkins and Pitcher 1982, Loughlin et al. 1984). Protocols for the 1994 survey were the same as for earlier aerial and on-land surveys (Braham et al. 1980, Calkins and Pitcher 1982, Withrow 1982, Merrick et al. 1991, Merrick et al. 1992, Loughlin et al. 1992, Sease et al. 1993).

Aerial Surveys

Adult and juvenile Steller sea lions were counted and photographed from an aircraft flying over rookeries and haulout

sites from Forrester Island (Southeast Alaska) to Attu Island (western Aleutian Islands) from 6 June through 29 June 1994 (Fig. 1, Tables 1 and 2). Although flights were designed to survey traditional sea lion rookeries and haul outs (Calkins and Pitcher 1982, Loughlin et al. 1984), potential haulout sites along the flight path were also 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. For logistical reasons the survey area was divided into three regions, each with separate aircraft and personnel: Southeast Alaska, from Dixon Entrance to Yakutat (ADF&G); the Gulf of Alaska, from Yakutat to Unimak Island (ADF&G); and the Aleutian Islands, from Unimak Island to Attu Island (NMFS).

Sea lions were photographed using a 35 mm auto-focus 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 (HI-8). Video recordings provided an overview of the entire site and served as a backup in case the slides were unusable.

In the laboratory, sea lions were counted from projected images (Sease et al. 1993).

Slides were analyzed in the laboratory using the same protocol as done in previous years (see Sease et al. 1993). NMFS counters repeated the process for any site when their results differed by 10% or more.

Photo counts were used when available. A visual count was only used when no photo counts were available for a particular site. The final count for each rookery or haulout was the mean of all individual counts, one for each counter for each series of slides. ADF&G counters used similar methods to those used by the NMML.

Ship-supported On-land Surveys

Sea lion pups were counted by NMFS and ADF&G survey teams between 27 June and 17 July at 33 rookeries from Forrester Island to Kiska Island. Pup counts at Forrester Island, White Sisters Island, and Hazy Island in Southeast Alaska were made by an ADF&G survey team transported to the beaches by the research vessel R/V *Medeia*. Counts of pups at rookeries in the eastern Gulf of Alaska (Wooded Island and Seal Rocks) and at Outer Island in the central Gulf of Alaska were made by survey teams transported to the sites by helicopter. Pup counts at seven rookeries between the central Gulf of Alaska to eastern Aleutian Islands (Sugarloaf to Akutan) were conducted by ADF&G personnel supported by the charter vessel M/V *Big Valley*. Pup counts from Akutan Island to Kiska Island were conducted by NMFS personnel supported by the charter vessel M/V *Maritime Maid*. Charter vessels delivered the

survey team to within 2-4 km of a site; the survey team then went ashore using small boats. After all sea lions other than pups were cleared from the beach, two or three biologists independently counted live pups on the beach and in the water. The final pup count for each rookery was the mean of several (typically two or three) independent counts by the biologist.

Data Analysis

Geographical regions used for analyzing survey results 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, Sease et al. 1993) and those adopted by the Steller Sea Lion Recovery Plan (NMFS 1992). The eight regions are as follows: 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 contains few haulout sites and only one rookery (Walrus Island in the Pribilof Islands). Of the 271 sites surveyed in 1994, 95 are trend sites that have been counted consistently in all recent surveys² (Table 2). These trend sites include the majority of animals observed (72.7% in 1994). Most of the other areas are small haulout sites. The only significant exceptions are the rookeries at Outer, Semisopchnoi, and Attu Islands. These

²This includes all 103 trend sites reported in Merrick et al. 1992. Some (e.g., Ugamak and Round Islands) are combined as one trend site here (Table 2).

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 Kenai Peninsula (Outer Island) to Kiska Island area. The Kenai to Kiska area includes four smaller regions: the central and western Gulf of Alaska and the eastern and central Aleutian Islands. This area is used as an index for population trends because it encompasses the center of the Steller sea lions' range and includes the major component of the Alaska sea lion population (61.8% of the non-pups on trend rookeries and 56.8% of the non-pups on all trend sites in 1994)(Merrick et al. 1987, NMFS 1992).

Analyses to determine population trends were performed for the sum of all trend sites (rookeries and haulout sites) and the sum of rookery trend sites for all of Alaska for the Kenai to Kiska area and for each subarea. Changes from 1992 to 1994 and from 1990 to 1994 were expressed as a percent of the earlier estimate. Annual rate of change from 1990 to 1994 and from 1992 to 1994 were estimated from 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 1992 to 1994 was tested using the significance of the slope for the regression. Significance of change from 1992 to 1994 was analyzed using a modified Student's t-test:

$$t_{d.f.} = \frac{C_{92} - C_{94}}{s.d.(C_{92} - C_{94})}$$

where t is the test statistic;
 d.f. is the degrees of freedom (the number of sites
 in the region under investigation - 1);
 C_{92} and C_{94} are the 1992 and 1994 counts, respectively; and
 $s.d.(C_{92} - C_{94})$ is the standard deviation for the
 difference between the 1992 and 1994 counts.

All calculations use the coefficient of variation (CV) from the 1992 aerial survey. During 1994 a replicate survey was flown in the eastern and central Aleutian Islands, hence CVs are available for those subareas. However, the 1994 CVs from the eastern and central Aleutian Islands were not used in any calculations, but rather to test the assumption that the survey variance in 1994 approximates the survey variance in 1992. In most cases, we assumed that the CV for the 1994 survey would have been the same as that for the replicate survey in 1992. CVs for the 1994 aerial survey are reported (see results section) but are used only for comparison with CVs from the 1992 aerial survey. Thus, the denominator in the above equation is estimated by the following:

$$\begin{aligned} s.d.(C_{92} - C_{94}) &= [\text{var}(C_{92}) + \text{var}(C_{94})]^{1/2} \\ &= [(CV_{92}C_{92})^2 + (CV_{92}C_{94})^2]^{1/2} \end{aligned}$$

where $\text{var}(C_{92})$ and $\text{var}(C_{94})$ are the variances for the 1992 and 1994 counts, and CV_{92} is the coefficient of variation for the 1992 count.

Percent change 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 where:

$$\% \text{ change} = \frac{C_{94} - C_{92}}{C_{92}} \times 100,$$

where C_{92} and C_{94} are the counts for 1992 and 1994, respectively.

Counts of pups at particular rookeries are most often counted 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 1993 and 1994) the mean count was used.

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 periods (e.g., less than 5% over a 3-year period), nor did we attempt to test the significance of trends for each of 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 32,945 adult and juvenile Steller sea lions were counted at 95 trend sites from Southeast Alaska through the western Aleutian Islands (Table 3). This represents a decline of 13.7% from the 1990 count of 38,154 and a 5.5% decline from the 1992 count of 34,844 (Fig. 2). Estimated annual rates of change were -3.7% ($P = 0.008$) for 1990-94 and -2.8% ($P < 0.05$) for 1992-94. At the 32 trend rookeries throughout Alaska, 23,452 adult and juvenile Steller sea lions were counted during the 1994 survey at the 32 trend rookeries throughout Alaska (Table 3). This was a decrease of 14.9% from 1990 numbers (27,563) and a decrease of 9.3% from counts in 1992 (25,849). Annual rates of change at trend rookeries for all Alaska were -3.9% ($P = 0.017$) for 1990-94 and -4.9% ($P < 0.005$) for 1992-94 (Table 3).

Kenai to Kiska

A total of 18,713 adult Steller sea lions were counted at 69 trend sites in the Kenai to Kiska region during the 1994 survey. This represents a 17.8% decline from 1990 (22,754) and a 9.5% decrease from the 1992 aerial survey (20,679) (Fig. 2, Table 3). Estimated annual rates of change were -4.9% ($P < 0.001$) for 1990-94 and -5.0% ($P < 0.001$) for 1992-94.

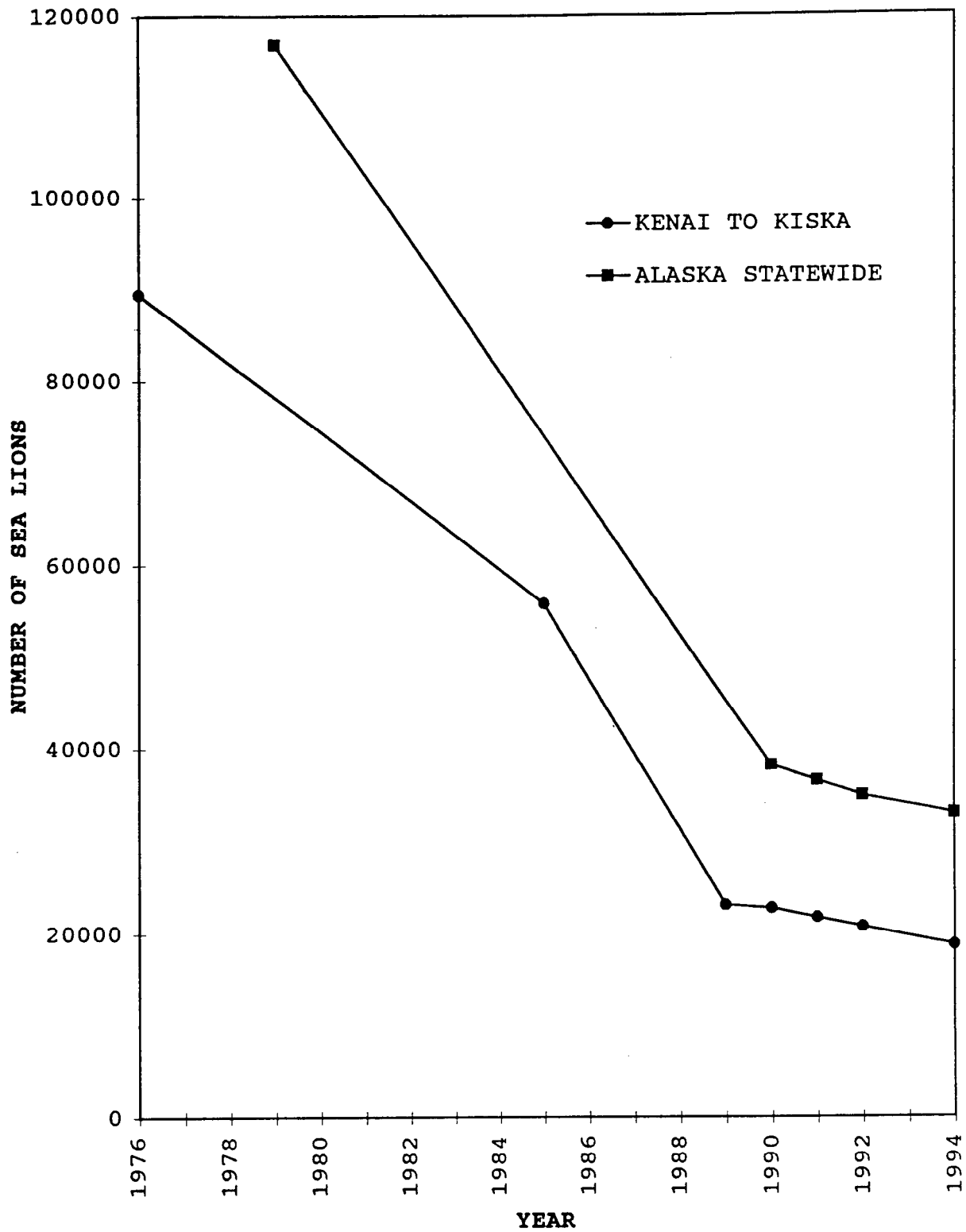


Figure 2. --Overall trend of Steller sea lion abundance based on counts at trend rookeries and haulout sites for Alaska statewide and for the Kenai to Kiska area.

At 26 trend rookeries in the Kenai to Kiska region, the numbers of Steller sea lions for 1990-94 (18,694 to 14,505) and 1992-94 (16,589 to 14,505) have decreased 22.4% and 12.6%, respectively (Table 3). Annual rates of change were -7.1% ($P = 0.028$) for 1990-94 and -6.7% ($P < 0.001$) for 1992-94.

Of the four subareas making up the Kenai to Kiska area, the central Gulf of Alaska and central Aleutian Islands showed declines in numbers of adult and juvenile Steller sea lions at trend sites (Fig. 3a, Table 4). Declines were 35.9% (7,050 to 4,520) for 1990-94 and 21.0% (5,721 to 4,520) for 1992-94 in the central Gulf of Alaska. Declines in the central Aleutian Islands were 27.5% (7,988 to 5,790) for 1990-94 and 9.5% (6,399 to 5,790) for 1992-94. Numbers of adult and juvenile Steller sea lions in the eastern Aleutian Islands increased by 16.3% during 1990-94; however, since 1992, their numbers decreased by 8.6%. The only subarea in the Kenai to Kiska area to show a consistent increase in sea lion numbers was in the western Gulf of Alaska: 1.7% from 1990 to 1994 and 7.0% from 1992 to 1994.

Changes were somewhat different regionally at trend rookeries in the Kenai to Kiska region (Fig. 3b, Table 5). From 1990 to 1994, declines ranged from 38.5% in the central Gulf of Alaska to 9.8% in the western Gulf of Alaska. From 1992 to 1994, declines ranged from 28.0% in the central Gulf of Alaska to 4.8% in the western Gulf of Alaska (Table 5).

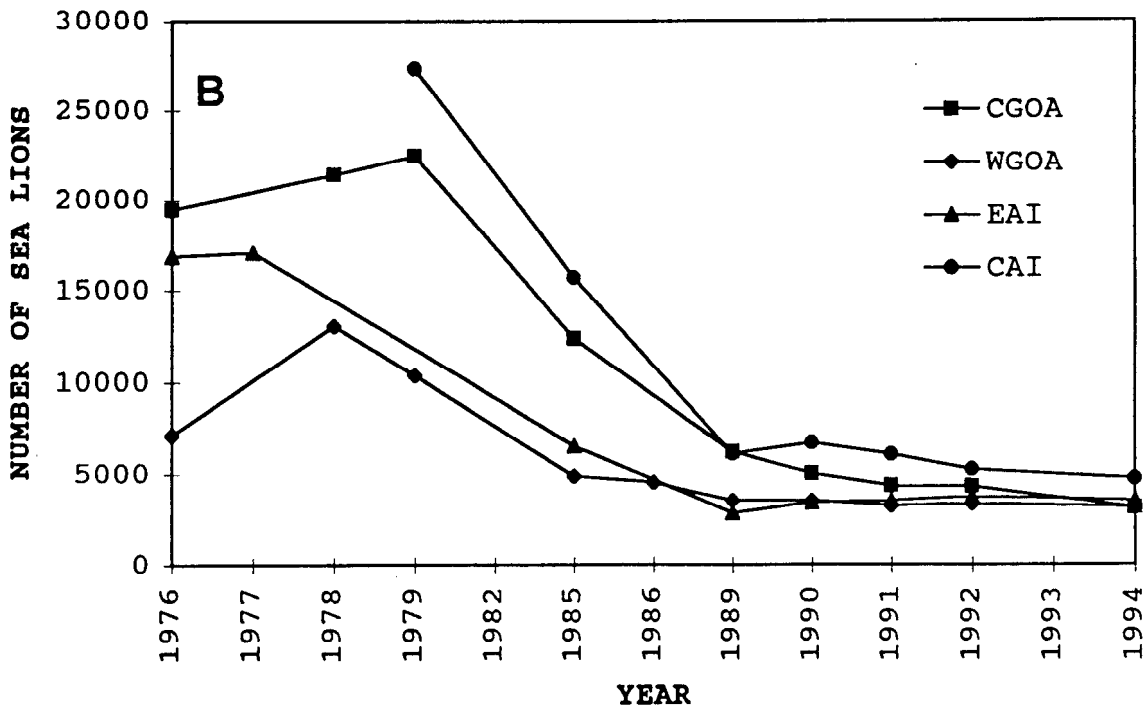
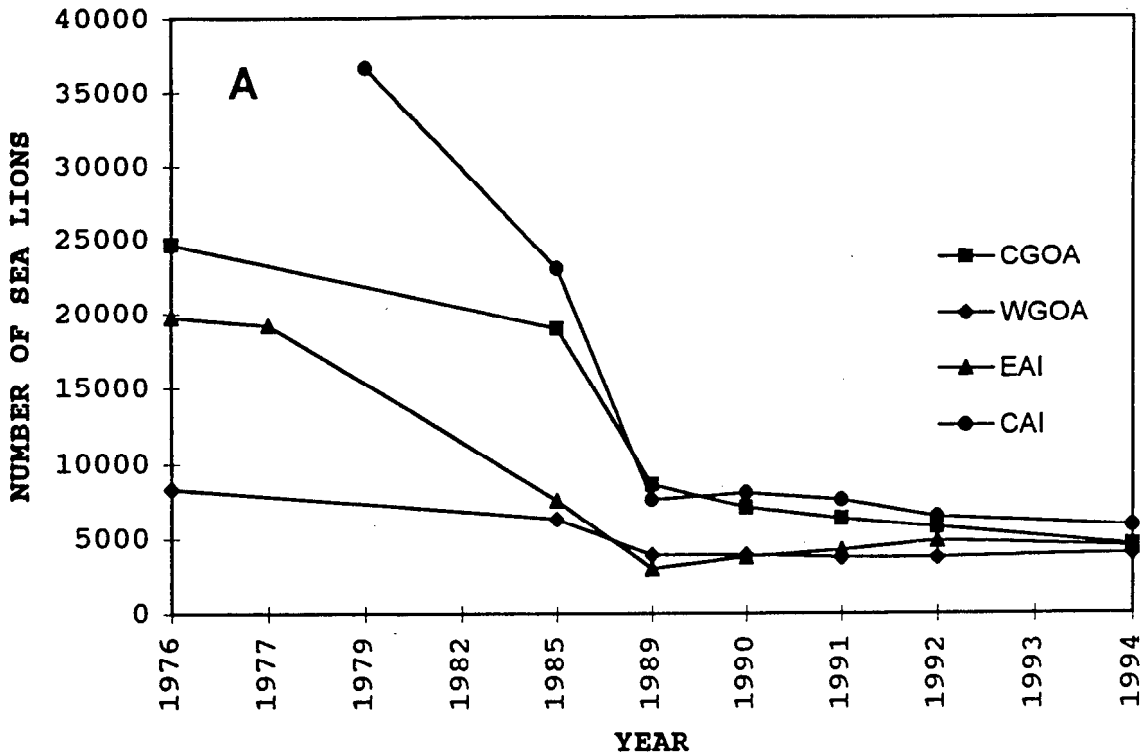


Figure 3.--Number of adult and juvenile Steller sea lions counted on trend rookeries and haulouts (A) and on trend rookeries (B) in the Kenai to Kiska area by region, 1976 to 1994: central (CGOA) and Western (WGOA) Gulf of Alaska; eastern (EAI) and central (CAI) Aleutian Islands.

The number of adult and juvenile Steller sea lions in the central Aleutian Islands declined 29.7% during 1990-94, but declined only 9.9% since 1992-94. In the eastern Aleutian Islands, counts on trend rookeries increased 2.9% for 1990-94 but decreased 5.3% from 1992 to 1994.

Individual rookeries within a region generally followed the pattern of the region in which they were located. In the central Gulf of Alaska, for example, counts at four of the five rookeries decreased by 18% or more since 1992 (\bar{x} = 28.75%, SD = 11.53) (Table 6).

In the Kenai to Kiska area, 77.5% of the sea lions counted on trend sites were on rookeries, with 22.5% on haul outs. Since the 1970s, this proportion has consistently been about 80%, except in 1985 when it dropped to 71.0% (Sease et al. 1993). Increases from 1992 to 1994 in the Kenai to Kiska region occurred only in the eastern Aleutian Islands. Decreases occurred in the central and western Gulf of Alaska and the central Aleutian Islands. Areas outside the Kenai to Kiska region experienced similar declines in the proportion of adults on rookeries. Southeast Alaska and the eastern Gulf of Alaska both declined while there was a slight increase in the western Aleutian Islands (Table 7).

In 1994 a replicate survey was carried out in the eastern and central Aleutian Islands. In the eastern Aleutian Islands, CVs were 7.1% for all trend sites and 6.0% for all trend rookeries. CVs were 3.9% and 5.0%, respectively, in 1992.

In the central Aleutian Islands, CVs were 5.0% for all trend sites and 6.1% for all trend rookeries, compared to 3.6% (all trend sites in 1992) and 4.0% (all trend rookeries in 1992).

Subareas outside the Kenai to Kiska Area

In Southeast Alaska, a total of 8,826 adult and juvenile Steller sea lions were counted on trend rookery and trend haulout sites. This observation continued the trend of increasing numbers of Steller sea lions in Southeast Alaska: 15.5% for 1990-94 and 16.6% for 1992-94. The number of Steller sea lions at trend sites in the eastern Gulf of Alaska continued to decrease, albeit at reduced rates. The 3,369 Steller sea lions counted in 1994 represented decreases of 38.1% from 1990 (5,444), but only decreased 9.9% from 1992 (3,738). The decline of Steller sea lion numbers in the western Aleutian Islands continued. Counts of 2,037 Steller sea lions in 1994 indicate a decline of 12.5% from 1990 (2,327). The number of sea lions in the western Aleutian Islands actually increased from 1991 to 1992 by 19.0% (2,411 to 2,869). This increase, however, was superceded by a 29.0% decrease from 1992 to 1994 (Fig. 4a, Table 4).

Counts of adult and juvenile Steller sea lions at trend rookery sites have decreased in the eastern Gulf of Alaska and western Aleutian Islands. Declines in sea lion abundance in the eastern Gulf of Alaska were 57.3% during 1990-94 (1,491 to 636) and 18.9% (784 to 636) for 1992-94. Declines in the western Aleutian Islands were 4.8% for 1990-94 (1,907 to 1,815) and 28.3%

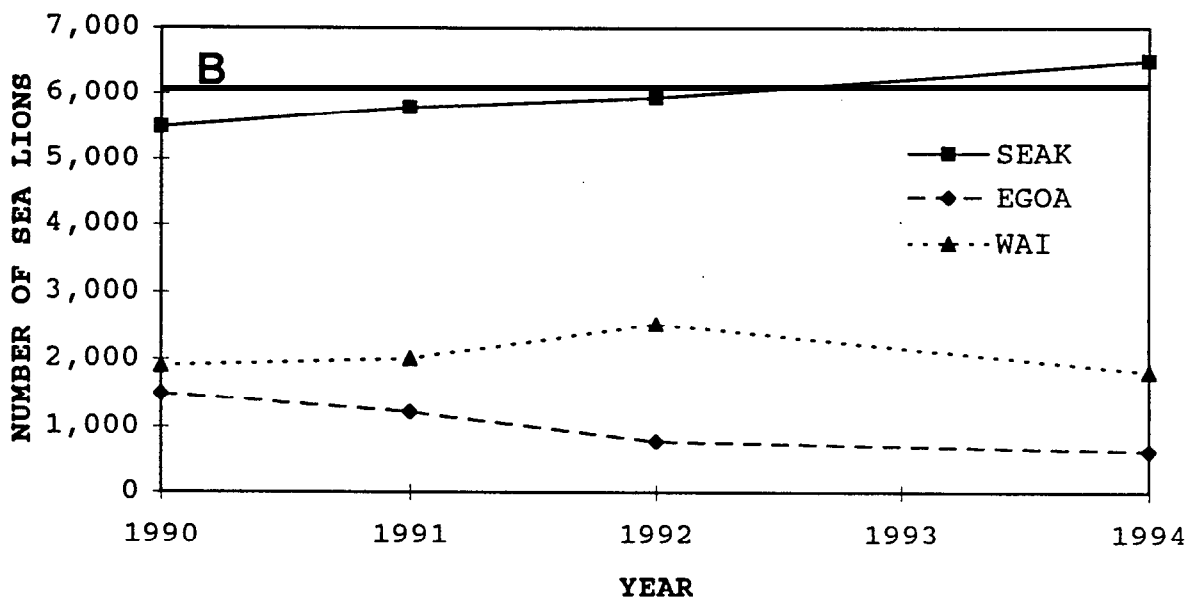
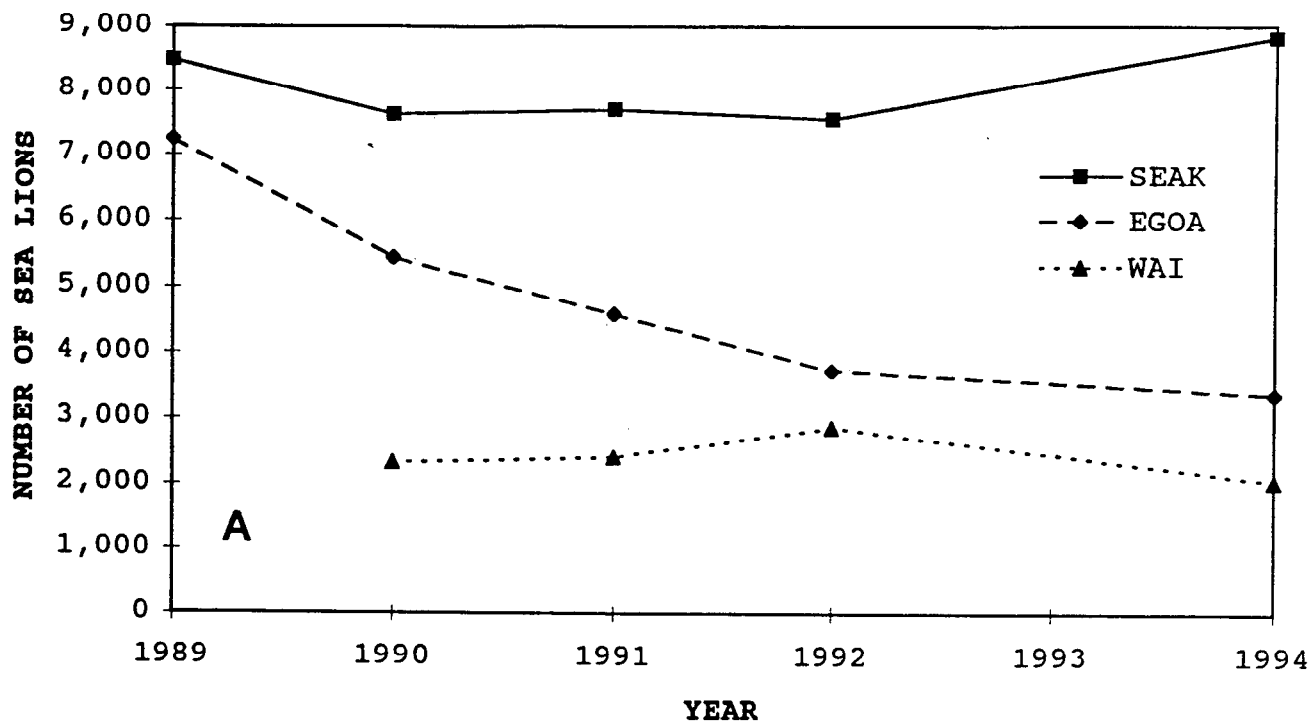


Figure 4. --Number of adult and juvenile Steller sea lions counted on trend rookeries and haulouts (A) and on trend rookeries (B) in regions outside the Kenai to Kiska area 1989 to 1994: Southeast Alaska (SEAK), eastern Gulf of Alaska (EGOA) and western Aleutian Islands (WAI)

for 1992-94 (2,531 to 1,815). The only subarea outside the Kenai to Kiska region to show an increase of adult Steller sea lions was Southeast Alaska. The number of Steller sea lions increased 18% from 1990 to 1994 (5,491 to 6,496) and 9% from 1992 to 1994 (Fig. 4b, Table 5).

Individual rookeries outside of the Kenai to Kiska area exhibited the general pattern of that region. In the western Aleutian Islands, for example, abundance at three of the four rookeries decreased by 24% or greater (Table 6).

Pup Surveys

In 1994, 13,850 live pups were counted at 33 rookeries from Southeast Alaska through the central Aleutian Islands (Table 2). Of the 33 rookeries counted in 1994, 11 were last surveyed in 1993, 5 were last surveyed in 1992, 1 was last surveyed in 1991, and 10 were last surveyed in 1990. Three rookeries were not counted in 1990, and three other rookeries that were counted in 1990 were excluded from this analysis due to possible erroneous counts (counts from skiff or ship). Of the 11 rookeries with comparable pup counts in 1993 and 1994, pup numbers increased at 4 rookeries and decreased at 7 rookeries (Table 8).

Pup numbers declined throughout all eight subareas of Alaska. Numbers of pups in Southeast Alaska have declined 11.4% (4,175 to 3,701) since 1991-92. This decrease was driven by the Forrester Island complex where pup numbers decreased 15.5% since 1991-92, more than offsetting modest increases of fewer than 50

pups per site at the two other principle rookeries in Southeast Alaska. In the eastern Gulf of Alaska the number of pups at Seal Rocks decreased 11.4% from 1991-92 to 1993-94 (657 to 582). Seal Rocks is the only rookery counted consistently in the eastern Gulf of Alaska. The number of pups at the Wooded Island rookery in the eastern Gulf of Alaska declined 40.7% (514 to 305) from 1993 to 1994. Previous counts from Wooded Island occurred in the late 1970s.

In the central Gulf of Alaska, numbers of pups fell 27.4% (4,083 to 2,963) since the 1991-92 surveys. Pups counted in the central Gulf of Alaska have decreased at all rookeries since 1991-92.

Numbers of pups counted in the western Gulf of Alaska have decreased 8.0% (1,923 to 1,770) from counts in 1991-92. Decreases from 1991-92 were seen at all rookeries in the western Gulf of Alaska with the exception of Clubbing Rocks.

In the eastern Aleutian Islands, pup numbers have declined by 14.5% (1,936 to 1,656) since 1991-92. This percent change excludes Adugak and Ogchul, which were not counted in 1991 or in 1992. Since 1991-92, all rookeries, with the exception of Akutan in the eastern Aleutian Islands, has experienced declining pup numbers.

Prior to 1994, pup counts in the central Aleutian Islands were last conducted in 1990. Since then, the number of pups at eight rookeries in the central Aleutian Islands that were also counted in 1994 have declined 25.6%. All rookeries in the

central Aleutian Islands have declined from 1989-90 counts. The pup counts for 1994 at Adak, Kasatochi, and Ulak are not included in this analysis due to possible erroneous counts. They were, however, last counted in 1985, and all have shown decreased counts of pups (Table 8)

DISCUSSION

Decreases observed in the Alaska Steller sea lion population during the 1994 aerial and ship-based survey indicate declines seen in previous surveys are continuing (Merrick et al. 1987, Loughlin et al. 1990, Merrick et al. 1991, Merrick et al. 1992, Sease et al. 1993). From 1992 to 1994, the annual rate of change of adult Steller sea lions on trend sites in Alaska was -2.8%, and -5.0% on trend sites in the Kenai to Kiska area. For 1990 - 1992, the annual rate of change was -4.5% for trend sites throughout Alaska and -4.8% for trend sites in the Kenai to Kiska region (Sease et al. 1993). Despite the overall decrease in adult and juvenile Steller sea lion numbers throughout Alaska and in the Kenai to Kiska region, the number of sea lions increased on trend rookery and haulout sites in some subareas. In Southeast Alaska, numbers of adult and juveniles (but not pups) have risen steadily since 1990. The western Gulf of Alaska has also shown a similar pattern of increasing sea lion numbers. These small increases in absolute numbers, however, have been offset by the larger absolute declines in other subareas of

Alaska (eastern, central Gulf of Alaska and eastern, central, western Aleutian Islands).

York et al. (1996) discuss the continuing decline of Steller sea lions in terms of a "background rate of decline." From 1975 to 1985 and since 1990 the background rate of decline for sea lions in the Kenai to Kiska area has been around 6.9% per year. However, during 1985-90 the Kenai to Kiska Steller sea lion population experienced a sharper rate of decline of 15.6% per year. The model of the Kenai to Kiska population of York et al. (1996) suggests that if the current 6.9% background rate of decline continues without any additional perturbations the probability of extinction of the female segment of the population is $P = 0.75$ after 145 years. However, if additional declines occur which approximate the levels of the 1985-90 rate, then the time to extinction at $P = 0.75$ level decreases to 110 years.

Pup production declined in all subareas of Alaska. From 1991-92 to 1993-94, pup production declined 27% in the central Gulf of Alaska and 8% in the western Gulf of Alaska. Decreases of 11% to 15% were observed in Southeast Alaska and the eastern and central Aleutian Islands from 1991-92 to 1993-94. Overall pup production declined by 13% for rookeries that are directly comparable between the 1991-92 and the 1993-94 surveys. This is the same percent decline as experienced by adult and juvenile Steller sea lions inhabiting rookeries in the Kenai to Kiska area from 1992 to 1994.

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. Merrick et al. 1988 reported significant declines in the proportion of juveniles at Ugamak Island (eastern Aleutian Islands) from 1977 to 1985-86. Chumbley et al. (in prep) report that the number of juvenile Steller sea lions on Marmot Island, Alaska (central Gulf of Alaska), appears to have declined more precipitously than other age groups. Another possible indication of high juvenile mortality at Marmot Island is the low return rate of pups branded in 1987 and 1988 (Chumbley et al. unpub. data). Tag resights have been approximately an order of magnitude lower than the number expected to be alive. York (1994) suggests that the observed declines of adult sea lions in the vicinity of Marmot Island, Alaska, may be due to a 10%-20% decrease in juvenile (0-3 year) survival coupled with slight decline in adult survival rates (0.03%).

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Table 1.--Steller sea lion aerial survey schedule in Southeast Alaska, the Gulf of Alaska, and the Aleutian Islands, June 1994.

Date	Departure	Destination	Areas surveyed
<u>Southeast Alaska survey, Alaska Department of Fish and Game.</u>			
6/12			Southeast Alaska
6/13			Southeast Alaska
6/14			Southeast Alaska
<u>Gulf of Alaska survey, Alaska Department of Fish and Game</u>			
6/10			Eastern Gulf of Alaska, Prince William Sound
6/11			Kenai Peninsula, Barren Islands, Kodiak Archipelago
6/12			Kodiak Archipelago, Alaska Peninsula, Chirikof Island, Chowiet Islands, Shumagin Islands
6/13			Unimak Island
6/14			Alaska Peninsula, Unimak Island
<u>Aleutian Islands survey, National Marine Fisheries Service</u>			
6/15	Dutch Harbor	Dutch Harbor	Krenitzen Islands
6/16	Dutch Harbor	Dutch Harbor	Unalaska, Bogoslof, Umnak, Ogchul, Vsevidof, Adugak, Samalga, The Pillars, Emerald, Krenitzen Islands
6/17	Dutch Harbor	Adak	Islands of Four Mountains, Yunaska, Seguam, Amlia, Atka, Kasatochi Islands
6/20	Adak	Adak	Adak Island, Delarof Islands, Rat Islands
6/22	Adak	Shemya	Andreanof Islands, Rat

Table 1. --Continued.

Date	Departure	Destination	Areas surveyed
<u>Aleutian Islands</u> survey (continued)			
6/23	Shemya	Dutch Harbor	Andreanof Islands, Seguam, Islands of Four Mountains
6/24	Dutch Harbor	Dutch Harbor	Krenitzen Islands, Unimak and Sanak Islands, Sandman Reef, Amak
6/27	Dutch Harbor	Adak	Unalaska and Umnak Islands, Islands of Four Mountains, Seguam, Andreanof Islands
6/28	Adak	Adak	Rat, Delarof, Andreanof Islands
6/30	Adak	Shemya	Andreanof Islands, Semisopochnoi, Rat Islands, Buldir

Table 2. --Counts of Steller sea lions at rookery (*) and haulout locations in Alaska during June and July 1994. 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	6/13	P	104		
Wolf Rock	6/12	P	72		
Pinta Rocks	6/13	V	0		
The Sisters	6/14	V	0		
Inian Island	6/13	V	0		
St. Lazaria I.	6/12	V	0		
Sunset Island	6/14	V	10		
Sea Lion Rock+	6/13	V	0		
Cape Cross+	6/14	P	128		
Point Lull	6/14	V	0		
Tenakee Cannery Point	6/14	V	4		
Forrester Island+*	6/12	P	4,013	6/30	2,757
Turnabout Island+	6/13	V	0		
Jacob Rock+	6/12	P	236		
Biali Rock+	6/12	P	416		
Coronation Island+	6/12	P	142		
Cape Addington	6/12	P	892		
Timbered Island	6/12	P	201		
Hazy Islands+*	6/12	P	1,615	7/1	862
Cape Ommaney	6/12	P	428		
Vasha Island	6/12	V	0		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
Southeast Alaska (continued)					
Round Rock	6/13	V	0		
The Brothers+	6/14	P	423		
White Sisters+*	6/13	P	868	7/2	151
Benjamin Island	6/13	V	0		
Cape Bingham	6/13	V	0		
Graves Rock+	6/13	P	733		
Cape Fairweather+	6/13	V	0		
South Marble I.	6/13	P	146		
Venisa Point	6/13	V	0		
Sail Island	6/14	P	44		
Circle Point	6/13	V	0		
Cape Bartolome	6/12	P	32		
Harbor Point+	6/13	P	252		
Dorothy	6/13	V	0		
Easterly Island	6/12	P	97		
Emmons Island	6/14	V	0		
False Point Pypus	6/13	V	4		
Grindall Island	6/12	V	0		
Point Islet	6/12	V	0		
Kaiuchali (Biorka)	6/12	V	19		
Larch Bay	6/12	V	0		
Point League	6/14	V	0		
Point Marsh	6/12	P	110		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
Southeast Alaska (continued)					
Mist Island	6/13	V	0		
West Rock	6/12	P	798		
Sakie Point	6/12	V	0		
Patterson Point	6/12	V	0		
Point Carolus	6/13	V	0		
Eldred Rock	6/13	V	0		
Subtotals for Southeast Alaska			_____	_____	
All 50 sites			11,787		
13 trend rookery and haulout sites			8,826		
3 trend rookery sites			6,496		3,770
<u>Eastern Gulf of Alaska</u>					
Sitkagi Bluffs+	6/10	V	0		
Cape St. Elias+	6/10	P	781		
Middleton	6/10	V	0		
Hook Point	6/10	P	155		
Cape Hinchinbrook	6/10	P	111		
Seal Rocks+*	6/10	P	636	7/2	598
Fish (Wooded)+	6/10	P	649	7/2	305
Pleiades	6/10	V	0		
Glacier+	6/10	P	349		
Perry	6/10	V	0		
Point Eleanor	6/10	V	0		
The Needle	6/10	P	200		

Table 2.--Continued.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
Eastern Gulf of Alaska (continued)					
Point Elrington+	6/11	P	299		
Cape Puget	6/11	P	38		
Cape Junken	6/11	V	0		
Cape Fairfield	6/11	P	73		
Cape Resurrection	6/11	V	0		
Point Latouche	6/11	V	0		
Danger Island	6/11	V	0		
Granite Cape	6/11	V	0		
Steep Point	6/11	P	203		
Rabbit Island	6/11	P	21		
Aialik Cape	6/11	P	27		
Rugged+	6/11	P	157		
Chiswell+	6/11	P	180		
Seal Rock+	6/11	P	58		
Subtotals - Eastern Gulf of Alaska					
All 26 sites (pups at 2 rookeries)			3,997		903
10 trend rookery and haulout sites			3,369		
1 trend rookery site			636		598
Central Gulf of Alaska					
Outer*	6/11	P	406	7/3	119
Gore Point	6/11	V	0		
E. Chugach	6/11	V	0		

Table 2.--Continued.

Location	Adult and juvenile count		Pup count		
	Date(s)	Type ¹	Count	Date	Count
Central Gulf of Alaska (continued)					
North Kodiak Island					
Cape Elizabeth	6/11	P	114		
Sugarloaf+*	6/11	P	976	6/26	958
Rocks south of Ushagat+	6/11	P	27		
Ushagat+ ²	6/11	P	201		
W. Amatuli	6/11	V	10		
Latax Rocks+	6/11	P	230		
Sea Otter	6/12	P	206		
Tonki Cape	6/12	V	6		
Sea Lion Rocks+	6/12	P	62		
Marmot+*	6/12	P	1,091	6/27	804
Eastern Kodiak Island					
Long+	6/12	P	141		
Cape Chiniak+	6/11	P	191		
Ugak	6/11	V	1		
Gull Point	6/11	P	111		
Cape Barnabas+	6/11	V	0		
Two-headed+	6/11	P	365		
Sundstrom	6/11	V	0		
Cape Sitkinak+	6/11	P	87		
Tugidak	6/11	V	0		
Chirikof+*	6/12	P	433	6/28	325
Nagai Rocks	6/12	P	331		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>		<u>Pup count</u>		
	Date(s)	Type ¹	Count	Date	Count
Eastern Kodiak Island (continued)					
Chowiet**	6/12	P	599	6/28	625
Sutwik+	6/14	P	94		
Ugaiushak+	6/14	P	23		
Western Kodiak Island					
Cape Alitak	6/11	V	0		
Cape Ikolik	6/11	P	62		
Sturgeon Head	6/11	V	0		
Cape Ugat	6/11	P	273		
Noisy	6/11	V	0		
Malina Point	6/11	V	0		
Steep Cape	6/11	V	14		
Granite Cape	6/11	V	0		
Cape Paramanof	6/11	V	0		
Cape Uyak	6/11	V	0		
Cape Douglas	6/14	V	0		
Shakun Rocks	6/14	P	127		
Cape Nukshak	6/14	V	0		
Cape Ugiak	6/14	V	0		
Cape Gull	6/14	V	0		
Cape Kuliak	6/14	P	95		
Takli area	6/14	P	58		
Puale Bay	6/14	P	265		

Table 2 .--Continued.

Location	Adult and juvenile count		Pup count		
	Date(s)	Type ¹	Count	Date	Count
Western Kodiak Island (continued)					
Kilokak Rocks (New haulout south of Puale)	6/14	P	103		
Subtotals for Central Gulf of Alaska					
All 48 sites (pups at 5 rookeries)			6,795		2,831
15 trend rookery and haulout sites			4,520		
4 trend rookery sites			3,099		2,712
<u>Western Gulf of Alaska</u>					
Lighthouse Rocks	6/12	P	105		
Atkulik	6/14	V	0		
Kak	6/14	P	184		
Seal Cape	6/14	V	0		
Mitrofania	6/14	P	192		
Spitz+	6/14	P	20		
Kupreanof Point	6/14	P	75		
Haystacks	6/12	V	0		
Whaleback	6/12	P	324		
Castle Rock+	6/12	P	153		
Atkins+*	6/12	P	571	6/29	324
Chernabura+*	6/12	P	676	6/29	139
Twins	6/12	V	0		
Nagai Island+	6/12	P	88		
Sea Lion Rocks+	6/12	P	219		
Cape Unga	6/12	V	0		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>		<u>Pup count</u>		
	Date(s)	Type ¹	Count	Date	Count
Western Gulf of Alaska (continued)					
Jude	6/12	P	410		
Wosnesenski	6/12	V	0		
Pinnacle Rock+*	6/12,24	P	977	7/01	652
Clubbing Rocks+*	6/13,24	P	931	7/01	547
Cherni	6/13	P	105		
South Rock	6/14	P	342		
Bird+	6/13	P	347		
Rock	6/13	P	0		
Subtotals for Western Gulf of Alaska					
All 24 sites			5,719		
9 trend rookery and haulout sites			3,982		
4 trend rookery sites			3,155		1,662
<u>Eastern Aleutian Islands</u>					
Alaska Pen. Haulout	6/14	P	167		
Amak+ ²	6/14,24	P	681		
Sea Lion Rocks+*	6/14,24	P	480		
Unimak					
Cape Lutke	6/13	V	0		
Oksenof Point	6/24	P	185		
Scotch Cap	6/14	V	0		
Cape Sarichef	6/14,24	P	176		
Akutan					
Reef Point/ Lava Bight+	6/15,24	V	79		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
Akutan (continued)					
North Head	6/15,24	V	1		
Battery Point	6/15,24	V	0		
Cape Morgan+*	6/15,24	P	908	6/23	631
Akun					
Akun Head	6/15,24	V	0		
Billings Head+*	6/15,24	P	220	7/12	69
Jackass Point	6/15,24	V	0		
Tanginak	6/15,24	P	65		
Tigalda	6/15,24	P	137		
South side	6/15	P	127		
Basalt Rock	6/24	V	0		
Kaligigan	6/24	V	2		
Ugamak and Round Island+* ²	6/15,24	P	971	6/16,17	574
Aiktak	6/15,24	P	93		
Rootok	6/15,24	P	42		
Old Man Rocks	6/15,16,24	P	78		
Egg	6/15,16,24	P	22		
Unalaska					
Cape Izigan	6/16,23	P	243		
Spray Cape	6/16,27	P	77		
Makushin Bay	6/16	V	0		
Bishop Point	6/16,27	P	106		
Cape Wislow	6/16,27	V	0		
Priest Rock	6/15	P	20		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
Unalaska (continued)					
Korika Point	6/16	V	1		
Cape Kovrizhka	6/16	V	0		
Cape Starichikof	6/16,27	V	0		
Makushin Pt.	6/16	V	0		
Whalebone Cape	6/16	V	0		
Cape Sedanka	6/15,24	V	3		
Inner Signal	6/15,24	V	0		
Outer Signal	6/15,16,24	P	36		
Emerald	6/16,23	V	0		
Polivnoi Rock	6/16,23	P	53		
Pillars	6/16	V	0		
Ogchul+*	6/16,23	P	209	6/24	94
Vsevidof+	6/16,23	P	56		
Samalga	6/16	V	0		
Adugak+*	6/16,23	P	314	6/25	180
Umnak					
Cape Aslik+	6/16,27	P	90		
Cape Idak	6/16	V	0		
Cape Chagak	6/16	V	0		
Cape Udak	6/16	V	0		
Aguliuk Point	6/16	V	0		
Reindeer Point	6/16	V	0		
Bogoslof+*	6/16,27	P	413		

Table 2.--Continued.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
Subtotals - Eastern Aleutian Islands					
All 52 sites			6,055		
11 rookery and haul-out trend sites			4,421		
7 rookery trend sites (pups at 5 trend rookeries)			3,515		1,548
<u>Central Aleutian Islands</u>					
Chuginadak+	6/17,23,27	P	80		
Herbert+	6/17,23,27	V/P	35		
Kagamil+	6/17,27	V	1		
Uliaga	6/17,27	P	26		
Carlisle+	6/17,27	P	12		
Yunaska+*	6/23,27	P	426	6/26	217
Chagulak+	6/23,27	P	26		
Amukta+	6/23,27	P	15		
Seguam					
Saddleridge+*	6/23,27	P	658	6/27	444
Other+	6/23,27	P/V	260		
Amlia					
Sviechnikof*	6/23,27	P	139		
East Cape+	6/23,27	P	87		
South side	6/27	V	4		
Sagigik+	6/23,27	P	13		
Tanadak+	6/23,27	V	0		
Agligadak+*	6/23,27	P	8		
Atka					
North Cape+	6/17,27	P	53		

Table 2. --Continued.

Location	<u>Adult and juvenile count</u>		<u>Pup count</u>		
	Date(s)	Type ¹	Count	Date	Count
Central Aleutian Islands (continued)					
Salt+	6/27	V	0		
Great Sitkin	6/17	V	0		
Anagaksik+	6/20,23,27	V/P	28		
Fenimore	6/23,27	V/P	6		
Ikiginak+	6/27	V	2		
Oglodak	6/23,27	P	44		
Kasatochi+*	6/17,27	P	288	7/08	215
Koniuji	6/17,27	V	1		
Kagalaska	6/20,27	P	50		
Little Tanaga+	6/20,27	P	79		
Adak					
Cape Yakak/Lake Point+* ²	6/20,28	P	766	7/02	327
Argonne Point/Cape Moffet+ ²	6/22,28	V	0		
Crane	6/20,28	P/V	3		
Kanaga					
North Cape	6/22	P	30		
Ship Rock	6/20,28	P	93		
Bobrof	6/22,29	P/V	48		
Tanaga					
Bumpy Point	6/22,29	P	11		
Cape Sasmik	6/20,28	P	97		
Gramp Rock+*	6/20,28	P	537	7/03	425
Ugidak+	6/20,28	P	13		
Tag+*	6/20,28	P	310	7/03	234

Table 2.--Continued.

Location	Adult and juvenile count			Pup count	
	Date(s)	Type ¹	Count	Date	Count
Central Aleutian Island (continued)					
Kavalga+	6/20,28	P	21		
Unalga and Dinkum Rocks ²	6/20,28	P	142		
Ulak/Hasgox Point+*	6/20,28	P	866	7/03	638
Amatignak ²	6/20,28	P	97		
Gareloi	6/22	V	0		
Ilak	6/20,28	P/V	56		
Semisopochnoi*	6/22,29	P	346	7/07	21
Amchitka					
East Cape+	6/20,28	P	89	7/04	6
Cape St. Makarias	6/20,28	V/P	6		
Column Rocks*	6/20,28	P	188	7/04	114
Ivakin Point+	6/20,28	V	1		
Omega Point	6/20,28	V	1		
Bird Island	6/20,28	P/V	9		
Ayugadak+*	6/20,28	P	285	7/05	142
Rat	6/20,28	P	43		
Sea Lion Rocks	6/20,28	P	14		
Tanadak (Kiska)	6/20,28	P	99		
Little Sitkin	6/22,29	P	108		
Segula	6/22	V	1		
Kiska					
Sobaka-Vega Pt.	6/20,28	V/P	41		
Cape St.	6/20,28	P	233	7/06	120

Table 2.--Continued.

Location	<u>Adult and juvenile count</u>			<u>Pup count</u>	
	Date(s)	Type ¹	Count	Date	Count
(Kiska Island continued)					
Lief Cove+*	6/20,28	P	359	7/06	233
Pillar Rock	6/22,29	P	4		
Sirius Point	6/22,29	P	168		
Bukhti Point	6/20	V	0		
South Head	6/20	V	0		
Subtotals - Central Aleutian Islands					
All 65 sites (pups at 13 rookeries)			7,426		3,136
34 trend rookery and haulout sites			5,790		
11 trend rookery sites (pups at 10 trend rookeries)			4,736		2,995
<u>Western Aleutian Islands</u>					
Buldir+* ³	6/22,29	V/P	345		
Agattu+*	6/22	P	1,470		
Attu*	6/22	P	1,226		
Alaid+	6/22	P	222		
Shemya	6/22	P	106		
Nizki	6/22	V	0		
Subtotal - Western Aleutian Islands					
All 6 sites			3,369		
3 trend rookery and haulout sites			2,037		
2 trend rookery sites			1,815		
<u>Bering Sea</u>					
Walrus Island		L		7/12	61

Table 2--Continued.

Totals for Kenai to Kiska

All 189 sites	25,995	9,177
69 rookery and haul-out trend sites	18,713	
26 rookery trend sites	14,505	8,917

Totals for all regions of Alaska

All 271 sites	45,148	13,912
95 rookery and haul-out trend sites	32,945	
32 rookery trend sites	23,452	13,285

¹P = aerial photo count; V = aerial visual count; L = land 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 trend rookery and trend haulout sites in the Kenai to Kiska area and Alaska statewide for June and July aerial surveys from 1976 to 1994. 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
1994	14,505	18,713	23,452	32,945
<u>Overall change</u>				
1990-94	- 22%	- 18%	- 15%	- 14%
1991-94	- 15%	- 14%	- 10%	- 10%
1992-94	- 13%	- 10%	- 9%	- 5%
<u>Annual rate of change</u>				
1990-94	- 7.1% [*]	- 4.9% ^{***}	- 3.9% [*]	- 3.7% ^{**}
1991-94	- 5.6%	- 5.0% ^{***}	- 3.8%	- 3.3% [*]
1992-94	- 6.7% ^{***}	- 5.0% ^{***}	- 4.9% ^{**}	- 2.8% [*]

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 haulout trend sites in seven subareas of Alaska during June and July aerial surveys from 1990 to 1994. 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
1990	1,2,3	7,629	5,444	7,050	3,915	3,801	7,988	2,327
1991	4	7,715	4,596	6,273	3,734	4,231	7,499	2,411
1992	5	7,558	3,738	5,721	3,720	4,839	6,399	2,869
1994	6	8,826	3,369	4,520	3,982	4,421	5,790	2,037
<u>Overall change</u>								
	1990-94	+ 16%	- 38%	- 36%	+ 2%	+ 16%	- 28%	- 13%
	1991-94	+ 14%	- 27%	- 28%	+ 7%	+ 5%	- 23%	- 16%
	1992-94	+ 17%	- 10%	- 21%	+ 7%	- 9%	- 10%	- 29%

¹Sources: 1. Alaska Department of Fish and Game unpubl. data; 2. Douglas and Byrd 1991; 3. Merrick et al. 1991; 4. Merrick et al. 1992; 5. Sease et al. 1993; 6. 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 1990 to 1994. Totals include only those sites counted in all surveys (see 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
1990	1,2,3	5,491	1,491	5,043	3,496	3,417	6,738	1,907
1991	4	5,786	1,220	4,337	3,235	3,519	6,095	2,013
1992	5	5,945	784	4,306	3,313	3,712	5,258	2,531
1994	6	6,496	636	3,099	3,155	3,515	4,736	1,815
<u>Overall change</u>								
	1990-94	+ 18%	- 57%	- 39%	- 10%	+ 3%	- 30%	- 5%
	1991-94	+ 12%	- 48%	- 29%	- 3%	0%	- 22%	- 10%
	1992-94	+ 9%	- 19%	- 28%	- 5%	- 5%	- 10%	- 28%

¹Sources: 1. Alaska Department of Fish and Game unpub. data; 2. Douglas and Byrd 1991; 3. Merrick et al. 1991; 4. Merrick et al. 1992; 5. Sease et al. 1993; 6. This study

Table 6.--Counts of Steller sea lions at principal rookeries in Southeast Alaska, the Gulf of Alaska, and the Aleutian Islands for 1989 through 1994, including overall percent change (Δ 1994) between the count for each year and the count for 1994. Data sources are the same as for Tables 4 and 5.

Rookery	1989 (Δ 1994)	1990 (Δ 1994)	1991 (Δ 1994)	1992 (Δ 1994)	1994
<u>Southeast Alaska</u>					
Forrester	4,648 (-14%)	3,324 (+21%)	3,648 (+10%)	3,508 (+14%)	4,013
Hazy	1,462 (+10%)	1,187 (+36%)	1,278 (+26%)	1,576 (+2%)	1,615
White Sisters	734 (+18%)	980 (-11%)	860 (+1%)	861 (+1%)	868
<u>Eastern Gulf of Alaska</u>					
Seal Rocks	2,159 (-71%)	1,471 (-57%)	1,220 (-48%)	784 (-19%)	636
<u>Central Gulf of Alaska</u>					
Outer	350 (+16%)	589 (-31%)	334 (+22%)	243 (+67%)	406
Sugarloaf	1,861 (-48%)	1,319 (-26%)	1,216 (-20%)	1,184 (-18%)	976
Marmot	2,331 (-53%)	1,766 (-38%)	1,459 (-25%)	1,581 (-31%)	1,091
Chowiet	737 (-19%)	897 (-33%)	716 (-16%)	771 (-22%)	599

Table 6.--Continued.

Rookery	1989 (Δ1994)	1990 (Δ1994)	1991 (Δ1994)	1992 (Δ1994)	1994
<u>Central Gulf of Alaska (continued)</u>					
Chirikof	1,278 (-66%)	1,061 (-59%)	946 (-54%)	770 (-44%)	433
<u>Western Gulf of Alaska</u>					
Atkins	755 (+15%)	728 (+20%)	616 (-7%)	792 (-28%)	571
Chernabura	544 (+24%)	442 (+53%)	650 (+4%)	459 (+47%)	676
Pinnacle Rock	1,366 (-28%)	1,305 (-25%)	1,049 (-7%)	1,092 (-11%)	977
Clubbing Rocks	856 (+9%)	1,021 (-9%)	920 (+1%)	970 (-4%)	931
<u>Eastern Aleutian Islands</u>					
Sea Lion Rock	344 (+40%)	286 (+68%)	300 (+60%)	329 (+46%)	480
Ugamak and Round Islands	450 (+116%)	945 (+3%)	1,063 (-9%)	954 (+2%)	971
Akun (Billings Head)	150 (+47%)	118 (+86%)	156 (+41%)	271 (-19%)	220
Akutan (Cape Morgan)	578 (+57%)	765 (+19%)	818 (+11%)	1,061 (-14%)	908

Table 6.--Continued.

Locality	1989 (Δ 1994)	1990 (Δ 1994)	1991 (Δ 1994)	1992 (Δ 1994)	1994
<u>Eastern Aleutian Islands (continued)</u>					
Bogoslof	682 (-39%)	713 (-42%)	558 (-26%)	540 (-24%)	413
Ogchul	217 (-4%)	240 (-13%)	229 (-9%)	235 (-11%)	209
Adugak	392 (-20%)	350 (-10%)	395 (-21%)	322 (-2%)	314
<u>Central Aleutian Islands</u>					
Yunaska	466 (-9%)	391 (+9%)	398 (+7%)	393 (+8%)	426
Seguam (Saddleridge)	602 (+9%)	833 (-21%)	684 (-4%)	696 (-5%)	658
Agligadak	132 (-94%)	274 (-97%)	231 (-97%)	141 (-94%)	8
Kasatochi	659 (-56%)	641 (-55%)	466 (-38%)	376 (-23%)	288
Adak (Lake Point and Cape Yakak)	424 (+81%)	592 (+29%)	847 (-10%)	614 (+25%)	766
Gramp Rock	747 (-28%)	712 (-25%)	773 (-31%)	691 (-22%)	537
Tag	590 (-47%)	478 (-35%)	440 (-30%)	370 (-16%)	310

Table 6.--Continued.

Locality	1989 (Δ1994)	1990 (Δ1994)	1991 (Δ1994)	1992 (Δ1994)	1994
<u>Central Aleutian Islands (continued)</u>					
Adak (Hasgox Point)	1,123 (-23%)	1,324 (-35%)	1,046 (-17%)	1,059 (-18%)	866
Adchitka (Column Rocks)	nd ¹ (-)	197 (-5%)	233 (-19%)	194 (-3%)	188
Adchitka (East Cape)	nd ¹ (-)	106 (-16%)	151 (-41%)	162 (-45%)	89
Agadagak	389 (-27%)	401 (-29%)	324 (-12%)	313 (-9%)	285
Amisopochnoi	nd ¹ (-)	nd ¹ (-)	443 (-22%)	373 (-7%)	346
Aska (Lief Cove)	510 (-30%)	528 (-32%)	506 (-29%)	357 (+1%)	359
Aska (Cape Saint Stephen)	464 (-50%)	564 (-59%)	380 (-39%)	248 (-6%)	233
<u>Eastern Aleutian Islands</u>					
Adidir	1,058 (-67%)	729 (-53%)	589 (-41%)	454 (-24%)	345
Adattu (Cape Sabak)	1,680 (-43%)	1,178 (-19%)	1,429 (-33%)	1,304 (-27%)	961
Adattu (Gillon Point)	806 (-37%)	nd ¹ (-)	670 (-24%)	773 (-34%)	509

Table 6. --Continued.

Rookery	1989 (Δ1994)	1990 (Δ1994)	1991 (Δ1994)	1992 (Δ1994)	1994
<u>Western Aleutian Islands</u> (continued)					
Attu (Cape Wrangell)	nd ¹ (-)	nd ¹ (-)	736 (+14%)	755 (+11%)	839
<u>Kenai-Kiska</u> ² (from Table 3)	18,647 (-22%)	18,694 (-22%)	17,080 (-15%)	16,589 (-13%)	14,505
<u>Alaska</u> ³ (from Table 3)	30,388 (-23%)	27,563 (-15%)	26,099 (-10%)	25,849 (-9%)	23,452

¹nd = no data.

²Does not include Attu, Semisopochnoi, Amchitka, and Outer Islands.

³Excludes Attu, Semisopochnoi, 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 1990 to 1994. Only sites counted in all surveys are included (see Table 2).

Year	<u>of Alaska</u>				<u>Aleutian Islands</u>		
	Southeast Alaska	Gulf Eastern	Central	Western	Eastern	Central	Western
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
1994	0.737	0.189	0.686	0.792	0.795	0.818	0.891

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 1989 to 1990, 1991 to 1992, and 1993 to 1994 including the percent change (Δ 1993-94) from the earlier counts to the 1993-94 counts. Individual sites usually are counted on alternate years, thus two years are needed to complete a regional count.

Rookery	(Δ 1989/90-94)	(Δ 1991/92-94)	(Δ 1993-94)
<u>Southeast Alaska</u>			
White Sisters	30+ (+343%)	106 ⁵ (+25%)	133 ⁸
Hazy	494 (+64%)	808 (0%)	811 ⁸
Forrester	2,838 ⁶ (-3%)	3,261 (-15%)	2,757
<u>Eastern Gulf of Alaska</u>			
Seal Rocks	562 ⁶ (+4%)	657 (-11%)	582 ⁸
Fish (Wooded)	nd ⁴ (-)	nd ⁴ (-)	410 ⁸
<u>Central Gulf of Alaska</u>			
Outer	460 ⁶ (-67%)	180 (-17%)	150 ⁸
Sugarloaf	1,874 ⁶ (-49%)	1,001 (-4%)	958
Marmot	2,199 (-59%)	1,611 (-44%)	895 ⁸
Chowiet	582 ⁶ (+7%)	635 (-2%)	625
Chirikof	658 ⁶ (-49%)	656 (-49%)	335 ⁸

Table 8. --Continued.

Rookery	(Δ 1993-94)	(Δ 1991/92-94)	(Δ 1993-94)
<u>Western Gulf of Alaska (continued)</u>			
Atkins	435 (-14%)	485 (-23%)	372 ⁸
Chernabura	193 (-28%)	210 (-34%)	139
Pinnacle	nd ⁴ (-)	794 (-10%)	713 ⁸
Clubbing Rocks	nd ⁴ (-)	433 (+26%)	547
<u>Eastern Aleutian Islands</u>			
Ugamak	851 (-24%)	811 (-21%)	643 ⁸
Akun	63 (-5%)	63 (-5%)	60 ⁸
Akutan	442 (+43%)	556 (+13%)	631
Bogoslof	410 ⁶ (-21%)	501 (-36%)	322
Ogchul	nd ⁴ (-)	nd ⁴ (-)	94
Adugak	262 (-31%)	nd ⁴ (-)	180
<u>Central Aleutian Islands</u>			
Yunaska	358 (-39%)	nd ⁴ (-)	217
Seguam	607 ⁶ (-27%)	nd ⁴ (-)	444
Kasatochi	892 ⁷ (-76%)	nd ⁴ (-)	215

Table 8. --Continued.

Rookery	(Δ 1989/90-94)	(Δ 1991/92-94)	(Δ 1993-94)
Central Aleutian Islands (continued)			
Adak	558 ⁷ (-41%)	nd ⁴ (-)	327
Tag	357 (-34%)	nd ⁴ (-)	234
Gramp	448 (-5%)	nd ⁴ (-)	425
Ulak	1,236 ⁷ (-48%)	nd ⁴ (-)	638
Amchitka (Column Rocks)	148 (-23%)	nd ⁴ (-)	114
Ayugadak	163 (-13%)	nd ⁴ (-)	142
Kiska (Cape Saint Stephen)	235 ⁶ (-49%)	nd ⁴ (-)	120
Kiska (Lief Cove)	257 ⁶ (-9%)	nd ⁴ (-)	233
Bering Sea			
Walrus Island	nd ⁴ (-)	50 (+22%)	61

¹Loughlin et al. (1986) and Merrick et al. (1987).²National Marine Fisheries Service and Alaska Department of Fish and Game.³Merrick et al. 1992 and Sease et al. 1993.⁴nd = no data.⁵Mean of 1991 and 1992 counts.⁶Mean of 1989 and 1990 counts.⁷Count from 1985.⁸Mean of 1993 and 1994 counts.

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