Aerial, Ship, and Land-based Surveys of Steller Sea Lions (Eumetopias jubatus) in the Western Stock in Alaska, June and July 2003 and 2004

by

L. W. Fritz and C. Stinchcomb
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ABSTRACT

The National Marine Fisheries Service (NMFS) conducted aerial, land, and ship-based surveys of the western stock of Steller sea lions (Eumetopias jubatus) in Alaska during June and July 2003 and 2004. Survey effort in 2003 consisted of sea lion pup (newborn) counts from land or skiff/ship at 13 sites in the eastern Aleutian Islands and in the Gulf of Alaska. Efforts in 2004 included: (1) a medium-format (MF) photography, vertically-oriented aerial survey of adult and juvenile sea lions (non-pups) at 262 sites spanning the entire range of the western stock in Alaska, and (2) pup counts from land or skiff/ship at 20 sites in the central and eastern Aleutian Islands and in three sub-areas of the Gulf of Alaska.

Non-pup sea lion population trends in the western stock were analyzed using counts at groups of consistently surveyed sites: (1) ‘1970s trend sites’ (n = 93) - surveyed since the mid-1970s; (2) ‘1990s trend sites’ (n = 161), a group that includes all the 1970s sites and others surveyed since 1991; and (3) Kenai-Kiska trend sites – sites located between 150°W (Kenai Peninsula) and 177°E (Kiska Island). In all previous years, non-pups were counted from projected 35 mm slides. Comparison of non-pup counts from both 35 mm and MF images taken in June 2000 indicated that MF counts tended to be greater than 35 mm counts. To integrate the 2004 MF with the long-term 35 mm data for sea lion population trend analyses, sub-area totals of non-pup counts in 2004 were reduced by 3.64% to account for film format differences in resolution and orientation.
Non-pup counts at trend sites in the western stock increased 11-12% between 2000 and 2004. The trend observed between 2000 and 2002 continued from 2002 to 2004. Between 2000 and 2004, the estimated average annual rate of change at all the 1970s trend sites was +2.9% (P < 0.05), while at all 1990s trend sites, the annual rate of change was not significantly different from zero. These short-term trend data suggest that the overall decline in the western Steller sea lion population may have abated. However, the western population has not significantly increased in size and in 2004 was 28-30% smaller than in 1991, and 69% smaller than in 1985 at the Kenai-Kiska trend sites.

Changes in sea lion non-pup counts between 2000 and 2004 have not been uniform across the range of the western stock and appear to follow the pattern in sub-area trends observed in the 1990s. Between 1991 and 2000, the sea lion population in the core of the western stock’s range in Alaska (eastern and central Aleutian Islands and western Gulf of Alaska) was relatively stable, while the population at the eastern (eastern and central Gulf of Alaska) and western (western Aleutian Islands) edges declined considerably. Between 2000 and 2004, the decline in non-pup counts slowed at the edges, while increases were observed in the core.

While there are no recent (2003 or 2004) data for the western and much of the central Aleutian Islands, recent regional trends in pup counts were generally similar to those observed in non-pup counts. Pup counts in the eastern Aleutian Islands and eastern Gulf of Alaska have increased since 1998 but have been relatively stable since 1994 in the western Gulf of Alaska. Pup counts have been declining unabated in the central Gulf of Alaska since the 1980s and were the lowest on record in 2003-2004.
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INTRODUCTION

The Steller sea lion (*Eumetopias jubatus*) is the largest otariid pinniped species in the world (Loughlin et al. 1987, Hoover 1988). It inhabits coastal and continental shelf regions of the North Pacific Ocean. Along the eastern and northern Pacific coasts, its breeding range extends from central California, north through British Columbia, Canada and southeast Alaska, and west through the Gulf of Alaska, Bering Sea, and Aleutian Islands in the United States. Along the western Pacific coast, Steller sea lions breed along the Kamchatka Peninsula, on various Kuril Islands, and on islands within the Sea of Okhotsk in Russia (Loughlin et al. 1987, Hoover 1988). The National Marine Fisheries Service (NMFS) listed Steller sea lions as “threatened” range-wide under the U.S. Endangered Species Act (ESA) in November 1990 (55 Federal Register 49204). Since then, two population stocks have been identified based on differences in genetics and population trends (Bickham et al. 1996, Loughlin 1997). The ESA listing for the western stock, which breeds on rookeries located from 144°W (just east of Prince William Sound, Alaska) westward to Russia, was changed to “endangered” in June 1997 (62 Federal Register 24345). The eastern stock, which breeds on rookeries in southeast Alaska southward to California, retained its “threatened” ESA-classification (62 Federal Register 24345). The western stock has been further sub-divided into central and Asian stocks, with the boundary occurring west of Russia’s Commander Islands (Bickham et al. 1998).

The NMFS conducted aerial surveys of Steller sea lion non-pups (adults and juveniles), and land and ship-based surveys of pups across the range of the western stock in Alaska during June and July 2003 and 2004. These efforts extend the series of surveys in Alaska that began in the mid-1970s (Braham et al. 1980, Calkins and Pitcher 1982, Loughlin et al. 1984, Merrick et al.
1987, Loughlin et al. 1990; Merrick et al. 1991, Loughlin et al. 1992, Merrick et al. 1992, Sease et al. 1993, Strick et al. 1997, Sease et al. 1999, Sease and Loughlin 1999, Sease et al. 2001, Sease and Gudmundson 2002). This report focuses primarily on counts of pups (new-born), and adult and juvenile (non-pup; age 1+ years old) Steller sea lions at terrestrial rookery and haul-out sites from 1985 to 2004. Longer historical perspectives are included in Merrick et al. (1991: for 1956-90) and Sease et al. (1993: for 1976-92). Rookeries are those sites where adult male sea lions actively defend territories, pups are born, and mating takes place. Haul-out sites are those where sea lions rest on land (haul out), but where few or no pups are born (Calkins and Pitcher 1982, Loughlin et al. 1984). Trends in the size of the sea lion population are determined by analyzing time series of pup and non-pup counts at ‘trend’ sites that have been consistently surveyed over time.

METHODS

Aerial Survey of Non-Pups

The 2004 Steller sea lion non-pup counts were, for the first time, obtained from medium-format (MF) vertical photographs. In previous aerial surveys (e.g., Sease and Gudmundson 2002), adult and juvenile sea lions were counted from projected images of 35 mm photographic slides shot obliquely from the side windows of aircraft. Alternatively, if sea lions at a site were not numerous (≤ 10), an airborne observer made only a visual count. In 2004, however, all counts were made from MF photographic images taken on 10-29 June 2004 at 262 Steller sea
lion terrestrial rookeries and haul-out sites from Cape St. Elias (59° 48’N, 144° 36’W) to Cape Wrangell, Attu Island (52° 55’N, 172° 28’E; Fig. 1).

The 2004 MF aerial photographic survey of non-pup Steller sea lions was conducted by the Marine Mammal Division of the NMFS Southwest Fisheries Science Center. The survey was conducted with an AeroCommander aircraft (i.e., high-wing, low speed, survey plane) and photographs of rookeries and haulouts were taken with a MF (5-inch) military reconnaissance camera (with image-motion compensation) mounted in the belly of the aircraft. Photographs were taken vertically at altitudes of at least 700 feet between 0900 and 1700 local time when sea lions are most likely to be on land (Sease and Gudmundson 2002). Counts of sea lions from MF images were made using a dissecting scope (magnification ranging from 2X to 20X) mounted over a high intensity light table.

Analyses of non-pup counts focused on ‘trend’ sites. Trend sites are those rookeries and haul-out sites surveyed consistently over a period of time, thus allowing analyses of population trends on decadal scales. Three groups of trend sites were used:

- ‘1970s trend sites’ (n = 93): 30 rookeries and 63 haulouts consistently surveyed from the 1970s to the present. The ‘1970s trend sites’ typically have 70%-80% of all animals observed during each survey.
- ‘1990s trend sites’ (n = 161): sites consistently surveyed from 1991 to the present. This group includes all the ‘1970s trend sites’, but also includes 68 other rookeries and haulouts surveyed routinely since 1991. The ‘1990s trend sites’ typically have 91%-98% of all animals observed during each survey.
“Trend rookeries” (n = 30) are a subset of all rookeries, and are the 30 rookeries included in the ‘1970s trend sites’. The only major rookeries not included with the ‘trend rookeries’ are located on Outer and Attu Islands.

The distinction between rookeries and haul-out sites has become blurred in recent years as some sites traditionally listed as rookeries have produced few or no pups (e.g., Semisopochnoin Island, Agligadak Island, and Amchitka Island-Column Rocks). Conversely, noteworthy numbers of pups have been counted at some haul-out sites (e.g., Chiswell Islands, Jude Island and Kanaga Island-Ship Rock).

Geographical regions used for analyzing survey results were the same as those used in previous survey reports (Merrick et al. 1987, Loughlin et al. 1990, Merrick et al. 1991, Loughlin et al. 1992, Merrick et al. 1992, Sease et al. 1993, Strick et al. 1997, Sease et al. 1999, Sease and Loughlin 1999, Sease et al. 2001, Sease and Gudmundson 2002) and those adopted in the Final Recovery Plan for Steller sea lions (NMFS 1992). The NMFS aerial survey effort during 2004 covered six western-stock regions: the eastern, central, and western Gulf of Alaska and the eastern, central, and western Aleutian Islands (Fig. 1). Western stock terrestrial sites in the Bering Sea region, which contain few haul-out sites and only one rookery (Walrus Island in the Pribilof Islands), were not surveyed in 2004.

Another geographical region used during the analyses of survey data extends from the Kenai Peninsula (Outer Island) to Kiska Island. This index area includes all of the central and western Gulf of Alaska, and the eastern and central Aleutian Islands, and encompasses what historically was the heart of the Steller sea lions’ range (Merrick et al. 1987, NMFS 1992). The
Kenai-to-Kiska region typically has included between 74% and 88% of the western Alaska sea lion population. Except for the distinction between the eastern and western stocks, the geographical divisions used in this report are arbitrary and may not accurately reflect the underlying structure of the population. We present results for each region to identify and highlight varying population trends. However, readers should not think that sea lion populations in one region are separate and independent of those in other regions. York et al. (1996), using a cluster analysis based on location and similarities in population trends, derived groupings of rookeries (from Outer to Attu Islands only; central Gulf of Alaska through western Aleutian Islands) that were similar to those used here to present survey results. The only differences between the rookery clusters identified by York et al. (1996) and those used here are as follows:

- York et al. (1996) grouped Atkins Island with the central Gulf of Alaska instead of the western Gulf of Alaska, and
- York et al. (1996) grouped Buldir Island with the central Aleutian Islands instead of the western Aleutian Islands.

Comparison of Non-Pup Counts from Medium Format and 35 mm Film

From 24 to 29 June 2000, both MF and 35 mm film were used to photograph Steller sea lions on 20 rookery and haul-out sites in southeast Alaska, and the eastern and central Gulf of Alaska. Adult and juvenile Steller sea lions were counted from both types of film images at each site. Photographs were taken on the same day from different aircraft; the MF photograph was
always taken first, followed within minutes by the 35 mm photograph. Differences in counts at each site and in aggregate were determined and analyzed using a sign test (Sokal and Rohlf 1969).

Pup Surveys

Pups were counted at 9 rookeries (Ugamak/North, Ugamak/Ugamak Bay, and Ugamak/Round were considered a single site) and 4 haul-out sites between 20 June and 5 July 2003 and at 17 rookeries and 3 haul-out sites from 20 June to 6 July 2004. Numbers of pups on all rookeries in the eastern, central and western Gulf of Alaska, and in the eastern Aleutian Islands were counted once in either 2003 or 2004. Pups on rookeries west of Adak Island were not counted in either 2003 or 2004. This area included all of the western Aleutian Islands (four rookeries) and most of the central Aleutian Islands (7 of 11 rookeries). Most pup counts were performed by personnel directly on the rookery beach (beach counts), but others were made from a skiff or ship just offshore, or from a viewpoint overlooking the rookery beach. Beach counts were conducted by two or three people after most sea lions older than pups were safely cleared from the beach; all live pups on the beach and in the water were counted. The final pup count for each rookery was the mean of the two or three individual counts. Beach counts of pups introduce disturbance to the rookeries and are logistically difficult to conduct. Consequently, complete Alaska-wide pup counts are attempted only every 4 years, with counts at selected rookeries during intervening years.
Pup counts made from overlooks or from a skiff are done at several sites without disturbing sea lions off the beach. This is done at sites where only few pups were present or where vantage points offered clear views of the entire rookery beach. Shore-based observers counted pups daily at Marmot and Ugamak Islands from overlooks in June and July 2003 and 2004. Pups were counted on two separate beach rookeries on both Marmot and Ugamak Islands. Counts at each beach by separate observers were averaged, and the maximum daily sum for each island and year is reported here (Ugamak: 2004 only). It is not unusual for pups to be born at haul-out sites, although the numbers typically are very small in comparison to births at rookeries (Calkins and Pitcher 1982, Loughlin et al. 1984).

Pup Count Method Comparison: 1998-2002 Counts from the Beach and Medium Format Film

Pup counts from MF photographs taken at 16 rookery and haul-out sites within the range of the western stock in Alaska in late June-early July in 1998, 2000, 2001, and 2002 were compared with beach pup counts at the same sites taken within 4 days of each other. There were 18 comparisons of photographic counts to ground counts since two rookeries were photographed twice in the same year and straddled the ground count. Differences in counts at each site and in aggregate were determined and analyzed using a sign test (Sokal and Rohlf 1969), with particular attention to the order of the surveys.
Population Trend Analyses

To determine trends in the non-pup population, annual totals of non-pups at ‘1970s trend sites’, ‘1990s trend sites’, and trend rookeries were computed for each of the following regions:

- the western stock in Alaska (Cape St. Elias, 144°W to Attu Island, 172°E);
- the Kenai-to-Kiska index area (150°W to Kiska Island, 176°E); and
- within each of the six smaller geographical sub-areas.

Overall regional changes in numbers of non-pups for various time periods are expressed as a percentage of the earlier count. For instance, the percent change in numbers of non-pups at ‘1970s trend sites’ in the Kenai-Kiska area between 1985 (n = 54,738) and 2000 (n = 15,279) is \[
\frac{(15,279-54,738)}{54,738} = -72.1\%.
\]

Estimates of the annual rate of change (AR) for various time periods are derived from regression coefficients \((m)\) of log-linear regressions of the natural logarithm of the non-pup counts on the survey years; 

\[ AR = e^m - 1. \]

Tests of the significance of the regression coefficient \((H_0: m = 0 \text{ vs. } H_1: \ m \neq 0)\) were done at the 95% level \((P < 0.05)\).

Trends in pup counts were analyzed only by calculating the percent change in numbers for similar time periods and regions used in the non-pup analyses. The lack of annual time series for any of the regions precludes further statistical analyses.
RESULTS

Aerial Survey of Non-Pups

The June 2004 MF aerial survey resulted in a total count of 29,037 non-pup Steller sea lions on all surveyed sites (n = 262) in the western stock in Alaska (Table 1). Of these sites, 131 (50%) were occupied by more than 20 sea lions, 41 sites (16%) were occupied by 1 to 20 sea lions, and 90 sites (34%) were unoccupied. These rates of site occupancy by sea lions in 2004 were similar to those observed in 2002 (53% had more than 20 sea lions, 13% had 1-20, and 34% had none).

The 2004 aerial survey of non-pup Steller sea lions was the first to use MF vertical photogrammetry to obtain counts at all sites (except one), with counts in all previous surveys being made visually or from projected 35 mm slide images. For trend analyses, it is necessary to construct a consistent time series of counts and to know if the counts from MF and 35 mm images are comparable. Counts of non-pup Steller sea lions from 35 mm and MF film taken in June 2000 at 20 terrestrial sites were compared (Table 2). As expected, counts from the two film formats were highly correlated (Fig. 2A; \( r^2 = 0.995 \)). However, of the 20 paired counts available, the MF count was greater at 17 sites while the 35 mm count was greater at only 3, resulting in a skewed distribution of differences (MF-35 mm; Figure 2B). This result was tested against the hypothesis that the positive and negative differences were present in equal proportions, where \( p = \) proportion of differences with MF > 35 mm and \( q = \) proportion of differences with 35 mm > MF (\( H_0: p = q = 0.5 \) vs. \( H_1: p > q \)). Because of the better resolution and the vertical orientation of the
MF images, it was suspected that a MF count would be greater than one from a 35 mm image. Therefore, a one-tailed sign test (Sokal and Rohlf 1969) on the distribution of differences was performed. The cumulative probability of getting 17 or more positive and 3 or fewer negative differences in a sample of 20 is small (0.13%; P < 0.005). Therefore, the null hypothesis is rejected and these results suggest that more sea lions were counted on MF than on 35 mm images of the same site.

While MF counts tended to be greater than 35 mm counts, the magnitude of this difference was not consistent. The MF count exceeded the 35 mm count by less than 5% at 9 of 20 sites (45%), by 5%-10% at 6 sites (30%), and by more than 10% at only 2 sites (10%; Table 2). The average percent difference across all sites (including those where 35 mm > MF) was 4.19%, which is slightly greater (because of the positively skewed distribution) than the percent difference between the 35 mm and MF totals across all sites (3.08%). The true correction factor for the 2004 MF counts to make them comparable with the existing time series of 35 mm counts may lie between 3.08% and 4.19%. Therefore, for the purposes of population trend analyses, 2004 MF counts by sub-area and for the entire western stock were reduced by 3.64% (average of 3.08% and 4.19%) to make them compatible with the existing 35 mm time series. Adjustments of 2004 MF counts were not done on a site-by-site basis because of the large range in site-by-site percent differences (-2.61% to +17.21%; Table 2).

The adjusted 2004 total counts of non-pup sea lions in each group of trend sites (1970s, 1990s, and rookeries) in the Kenai-Kiska area and the western stock were larger than their respective 2000 and 2002 counts (Table 3; Fig. 3). Percentage increases from 2000 to 2004 in the three groups of trend sites ranged from 10% to 18% in the Kenai-Kiska area, and from 11%
to 16% in the entire western stock in Alaska. Estimated annual rates of change from 2000 to 2004 were significantly different from zero for four of the six aggregate trend site groups, and ranged from +2.4% to +4.2% (Table 3).

Although recent overall trends have been positive, the 2004 non-pup population is considerably smaller than counted in 1985, 1991 or 1996 (Table 3; Fig. 3). All of the 2004 trend site group totals were smaller than those of 1996, and the percent changes between 1991 and 2004 in the Kenai-Kiska area and throughout the Alaskan western stock ranged from -18% to -21%, and -28% to -30%, respectively. Looking at the previous 20 years, overall changes between 1985 and 2004 in non-pup counts at trend rookeries and ‘1970s trend sites’ in the Kenai-Kiska area were -65% and -69%, respectively.

Non-pup numbers at ‘1970s trend sites’ (Table 4; Figs. 4 and 5), ‘1990s trend sites’ (Table 5; Fig. 6), and trend rookeries (Table 6; Fig. 7) were greater in five of six sub-areas in 2004 than in 2002. The only sub-area where 2004 (adjusted) non-pup trend site counts were lower than in 2002 was the central Gulf of Alaska. However, while recent trend site counts have generally increased, only 2 of 18 estimated annual rates of change between 2000 and 2004 by sub-area were significantly different from zero (Tables 4-6), and both were positive and in the western Gulf of Alaska.

The numbers of non-pup sea lions at the edges of the western stock (eastern and central Gulf of Alaska and western Aleutian Islands) declined more sharply from 1991 to 2000 than in the central portion of its range (Tables 4-6; Fig. 5A). This pattern held for all three of the trend site groups and was responsible for the greater declines evident in the western stock as a whole than in the Kenai-Kiska index area. Since 2000, much of the central portion of the western
stock’s range has shown an increase in non-pup numbers while trends at the edges have been more mixed (Tables 4-6; Fig. 5B).

Analysis of trends in non-pup numbers at individual rookeries (Table 7) for periods including 2004 is confounded by the issue of counts and film format. Absolute counts (disregarding film format differences) increased at 20 of 31 principal rookeries between 2002 and 2004, and each increased by a minimum of 6%. The 20 increasing rookeries were located in 5 of the 6 sub-areas, with none occurring in the central Gulf of Alaska. The 11 rookeries that had declining numbers of non-pups between 2002 and 2004 included all 4 principal rookeries in the central Gulf of Alaska and 7 other rookeries in the western Gulf of Alaska (n = 1), and the eastern (n = 1) and central (n = 5) Aleutian Islands. Each of these rookeries had smaller absolute non-pup counts in 2004 than in 2002 despite the difference in film format resolution (Table 2). The non-pup count at the Yunaska Island rookery in the central Aleutian Islands may have been artificially low from disturbance because the aerial survey photographs were taken on the same day that a beach count of pups occurred (Table 1).

Pup Surveys

During June and July 2003 and 2004, live pups were counted at 27 different rookeries and haul-out sites in the eastern and central Aleutian Islands and eastern, central and western Gulf of Alaska (Tables 1 and 8). This includes all sites counted from the beach, a skiff or ship offshore, or from an overlook by either ship-based or field camp personnel. No rookeries west of Adak
Island in the central Aleutian Islands were visited in 2003 or 2004. Trends in pup counts for the entire western stock in Alaska are available only through 2002 because of the lack of recent counts in much of the central and all of the western Aleutian Islands. Trends in pup counts by sub-area through 2004 are available only for the three Gulf of Alaska sub-areas and for the eastern Aleutians Islands (Table 9; Figs. 8 and 9). Since 1998, pup counts have increased in the eastern and western Gulf of Alaska and the eastern Aleutian Islands, but have continued to decrease in the central Gulf of Alaska and the central and western Aleutian Islands (through 2002).

Pup counts from MF images and from beach counts at the same location were compared if they were conducted no more than 4 days apart (Table 10 and Fig. 10). Paired counts were highly correlated ($r^2 = 0.99$; Fig. 10A). In addition, there was little pattern associated with the differences between pairs of counts (Fig. 10B). A two-tailed sign test (Sokal and Rohlf 1969) was performed on these proportions, where $p =$ proportion of differences with MF > beach and $q =$ proportion of differences with beach > MF ($H_0: p = q = 0.5$ vs. $H_1: p \neq q$). The cumulative probability of getting the observed distribution is high (48%; $P > 0.5$). Therefore, the null hypothesis cannot be rejected and these results suggest that one technique did not systematically yield higher sea lion pup counts than the other.

Pup counts were also analyzed to determine if the order in which the surveys were conducted affected the count. Since disturbance to the animals from beach counts exceeds that of aerial surveys, counts may be most similar in instances when the MF survey preceded the

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1 An incomplete beach count was conducted on Lake Point, Adak Island on 21 June 2004, and the total ($n = 295$) is considered an underestimate of the actual number of pups present and is not reported in Tables 1 or 8.
beach count (assuming that the disturbance associated with the beach count itself did not reduce the number of pups on the beach). There were 14 paired observations when the MF survey occurred 1-4 days prior to the beach count (Table 10; MF count < beach count for 9 pairs; MF count ≥ beach count for 5 pairs). The cumulative probability of getting the observed distribution and the result of the two-tailed sign test (Sokal and Rohlf 1969) were similar to those when all the data were analyzed (42%; P > 0.5). For the four pairs of counts when the MF survey occurred 1-4 days after the beach count, the MF count was less than the beach count in two, equal in one and greater in one. Even though there are limited data to address situations where the MF survey occurred after the beach count, these analyses suggest that the order in which the surveys occurred did not affect the sign of the difference between the counts.

DISCUSSION

From 1989 to 2000, the western population of Steller sea lions in Alaska, as indexed by counts of adults and juveniles at trend sites, declined at an average rate of about 5% per year (Sease et al. 2001), and at rates as high as 15% per year in the late 1980s (Merrick et al. 1991). Since 2000, index counts of sea lions have increased. Sease and Gudmundson (2002) reported a 5.5% increase in western stock non-pup numbers at trend sites between 2000 and 2002, and data reported here suggest that this trend continued between 2002 and 2004. Annual rates of increase between 2000 and 2004 at trend sites, while not all significantly different from zero, were in the range of +2.4% to +4.2%. Thus, evidence from two consecutive surveys suggests that the decline in the western stock of Steller sea lions as a whole has abated.
While increases in non-pups between 2000 and 2002 occurred throughout the range of the western stock (Sease and Gudmundson 2002), 2004 counts in the central Gulf of Alaska were the lowest on record and those in the western Aleutian Islands and eastern Gulf of Alaska were largely unchanged from 2002. Therefore, the 2000-2004 increases in aggregate Kenai-Kiska or Alaskan western stock indices were driven by changes in the western Gulf of Alaska and eastern and central Aleutian Islands populations. Throughout the 1990s, non-pup counts in this central part of the range were generally stable or only slightly decreasing, while at the ends, they declined at much faster rates. While declines at the edges of the Alaskan western stock appear to have slowed, they do not appear to have stopped, particularly in the central Gulf of Alaska. Therefore, there is considerable geographic variation in the recent trends in non-pup Steller sea lion numbers in the Alaskan western stock, and it is not possible to make conclusions regarding broad-based stability or recovery of the population.

Regional trends in pup numbers, where available, largely support the observed non-pup trends. Pup counts in the eastern Aleutians and at rookeries visited in the central Aleutians (east of Adak Island) have shown recent increases. However, pup counts in the western Gulf of Alaska have been largely constant since 1994, while they have continued to decline in the central Gulf of Alaska.

Integration of non-pup counts from MF images into the existing time series of counts from 35 mm slides requires further study. The non-pup count comparisons reported here suggest that counts from MF images are higher, but the magnitude of the correction factor, particularly on a site-by-site basis is uncertain. Differences in terrain and substrate between sites may yield a different relationship between 35 mm and MF counts, and therefore, different correction factors.
The non-pup correction factor for MF aggregate counts used in this report (-3.64%) is considered provisional and will be investigated further in a comparative study planned for 2005.

In comparison to the non-pup time series, there are fewer data available for comparison of MF counts and beach counts of pups. However, based on these limited analyses, as well as those of Snyder et al. (2001), the two techniques yield similar results and neither tended to produce greater or smaller counts than the other. This suggests that MF photogrammetry could yield an index of pup counts throughout the range of the western stock in Alaska that is consistent with the existing beach count time series if the survey time frames are similar. Additional comparisons of MF and beach counts of pups are planned for 2005.

ACKNOWLEDGMENTS

We thank the pilots of Commander Northwest for aircraft transportation during the aerial survey, and M. Lynn who participated in the survey. We thank the captain and crew of the R/V Tiglax for vessel support during pup counts in the Gulf of Alaska and Aleutian Islands. We greatly appreciate the wide-ranging assistance from personnel of the Alaska Maritime National Wildlife Refuge in Homer, Alaska, and especially K. Sundseth of the Refuge’s Aleutian Islands Unit on Adak Island. The National Marine Fisheries Service Observer Program, the Dutch Harbor Airport Manager, and Delta Western Fuels provided valuable assistance in Dutch Harbor, Alaska. Many individuals including NMFS personnel and cooperating scientists participated in pup counts on ship-based surveys and from field camps. T. Gelatt, E. Logerwell and R. Towell provided comments on early drafts of the manuscript, and G. Duker and J. Lee provided editorial
support. This fieldwork was conducted under the authority of NOAA MMPA/ESA Permit No. 782-1532-00 and Special Use Permit No. 51576 from the Alaska Maritime National Wildlife Refuge.
CITATIONS


(Eumetopias jubatus) in the Gulf of Alaska and Aleutian Islands during June 1989. U.S. 


sea lions in Southeast, Alaska, the Gulf of Alaska, and Aleutian Islands during June and 

based surveys of northern sea lions, (Eumetopias jubatus) in the Gulf of Alaska and 
NMFS F/NWC-196, 34 p.


(Eumetopias jubatus). Prepared by the Steller Sea Lion Recovery Team for the National 
Marine Fisheries Service, Silver Spring, Maryland, 92 p.

Sease, J. L., and C. J. Gudmundson. 2002. Aerial and land-based surveys of Steller sea lions 
(Eumetopias jubatus) from the western stock in Alaska, June and July 2001 and 2002. U. 


Table 1.—Counts of Steller sea lions at rookery (R) and haul-out sites in Alaska, June and July 2003 and 2004. All adult and juvenile (non-pup) counts are from medium-format photographs taken vertically over each site in June 2004. Pup counts are from on-site beach counts (B), from a skiff or ship just offshore (S), or from a land-based overlook (O; Type) in June and July 2003 and 2004. Trend (T) and 1990s trend (90T) sites are those sites used for analyses of trends in survey counts.  M = Month (June = 6, July = 7); D = Day.

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| USHAGAT/SW (T, 90T)                           | 6 | 25 | 101   | | | | | | •
| USHAGAT/ROCKS SOUTH (T, 90T)                  | 6 | 25 | 8     | | | | | |
| SUD                                           | 6 | 11 | 0     | | | | | |
| LATAX ROCKS (T, 90T)                          | 6 | 11 | 56    | | | | | |
| SEA OTTER (90T)                               | 6 | 24 | 127   | | | | | | •
| RK NEAR SEA OTTER (90T)                       | 6 | 24 | 10    | | | | | |
| AFOGNACK/TONKI CAPE (90T)                     | 6 | 24 | 0     | | | | | | •
| SEA LION ROCKS (MARMOT) (T, 90T)              | 6 | 25 | 2     | | | | | |
| MARMOT (R, T, 90T)                            | 7 | 6 | 2003 | 505 | O | | | |
| MARMOT (R, T, 90T)                            | 6 | 26 | 703   | 6 | 26 | 2004 | 474  | O | | |
| LONG ISLAND (T, 90T)                          | 6 | 24 | 32    | | | | | | •
| KODIAK/CAPE CHINIAK (T, 90T)                  | 6 | 25 | 87    | | | | | | •
| UGAK (90T)                                    | 6 | 26 | 0     | | | | | |
| KODIAK/GULL POINT (90T)                       | 6 | 26 | 109   | | | | | | •
| KODIAK/CAPE BARNABAS (T, 90T)                 | 6 | 26 | 0     | | | | | |
| TWOHEADED (T, 90T)                            | 6 | 26 | 266   | 6 | 29 | 2003 | 20   | S | | |
| SITKINAK/CAPE SITKINAK (T, 90T)               | 6 | 26 | 80    | | | | | | •
| KODIAK/SUNDSTROM                              | 6 | 11 | 0     | | | | | |
| KODIAK/CAPE ALITAK                            | 6 | 11 | 0     | | | | | | •
| KODIAK/CAPE IKOLIK                            | 6 | 11 | 108   | | | | | |
| KODIAK/TOMBSTONE ROCKS                        | 6 | 11 | 0     | | | | | | •
| KODIAK/CAPE KULIUK                            | 6 | 11 | 0     | | | | | | •
| KODIAK/CAPE UGAT (90T)                        | 6 | 24 | 2     | | | | | | •
| NOISY                                         | 6 | 24 | 0     | | | | | | •
| KODIAK/MALINA POINT                           | 6 | 24 | 0     | | | | | | •
| KODIAK/STEEP CAPE (90T)                       | 6 | 24 | 0     | | | | | | •
| KODIAK/CAPE PARAMANOF                         | 6 | 24 | 0     | | | | | | •
| SHAW                                          | 6 | 11 | 81    | | | | | | •
| CAPE DOUGLAS                                  | 6 | 11 | 0     | | | | | | •
| SHAKUN ROCKS (90T)                            | 6 | 11 | 104   | | | | | | •
| CAPE NUKSHAK                                  | 6 | 11 | 0     | | | | | | •
| CAPE UGYAK                                    | 6 | 11 | 0     | | | | | | •
| CAPE GULL                                     | 6 | 11 | 0     | | | | | | •
| TAKLI (90T)                                   | 6 | 11 | 85    | | | | | | •
| PUALE BAY (90T)                               | 6 | 11 | 58    | | | | | | •
| KILOKAK ROCKS                                 | 6 | 26 | 85    | | | | | | •
| AIUGNAK COLUMNS                               | 6 | 26 | 1     | | | | | | •
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1 In 2004, the count from Akun/Billingshead Rookery was made from projected 35 mm image shot obliquely from the side window of the aircraft.
Table 1. --(Continued).

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$^2$ Possibly a low non-pup count because of the on-land disturbance related to the pup count on the same day.
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATTU/MASSACRE BAY (90T)</td>
<td>6  17</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATTU/CHIRIKOF POINT (90T)</td>
<td>6  17</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATTU/CHICHAGOF POINT (90T)</td>
<td>6  17</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATTU/KRESTA POINT (90T)</td>
<td>6  17</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATTU/CAPE WRANGELL (R, 90T)</td>
<td>6  21</td>
<td>257</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Aleutian Islands Total</td>
<td>1,335</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Stock in Alaska Total</td>
<td>29,037</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2.—Counts of non-pup Steller sea lions from 35 mm (shot obliquely from side window of aircraft) and medium-format (MF; shot vertically) photographs taken at various sites in southeast Alaska, and eastern and central Gulf of Alaska in June 2000. Photographs were taken on the same day, minutes apart at each site. The medium-format photograph was always taken first. The percent difference ((Medium-35mm)/35 mm = % Diff) for each site is calculated along with the aggregate totals and percent difference for all sites. Time is Alaska Daylight Time, HH:MM.

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Time</th>
<th>35 mm</th>
<th>MF</th>
<th>% Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish I.</td>
<td>6/24/2000</td>
<td>10:10</td>
<td>408</td>
<td>421</td>
<td>3.31</td>
</tr>
<tr>
<td>Seal Rocks (PWS)</td>
<td>6/24/2000</td>
<td>10:30</td>
<td>820</td>
<td>846</td>
<td>3.23</td>
</tr>
<tr>
<td>White Sisters</td>
<td>6/24/2000</td>
<td>15:10</td>
<td>1,398</td>
<td>1,361</td>
<td>-2.61</td>
</tr>
<tr>
<td>Jacob Rock</td>
<td>6/24/2000</td>
<td>15:52</td>
<td>233</td>
<td>228</td>
<td>-1.94</td>
</tr>
<tr>
<td>Biali Rock</td>
<td>6/24/2000</td>
<td>16:10</td>
<td>662</td>
<td>669</td>
<td>1.13</td>
</tr>
<tr>
<td>Sea Lion Rock (Puffin)</td>
<td>6/24/2000</td>
<td>16:38</td>
<td>212</td>
<td>213</td>
<td>0.71</td>
</tr>
<tr>
<td>Cape Ommaney</td>
<td>6/24/2000</td>
<td>16:54</td>
<td>289</td>
<td>305</td>
<td>5.72</td>
</tr>
<tr>
<td>West Rock</td>
<td>6/25/2000</td>
<td>11:24</td>
<td>625</td>
<td>732</td>
<td>17.21</td>
</tr>
<tr>
<td>North Rock</td>
<td>6/28/2000</td>
<td>15:35</td>
<td>1,202</td>
<td>1,221</td>
<td>1.58</td>
</tr>
<tr>
<td>Lowrie I.</td>
<td>6/28/2000</td>
<td>15:50</td>
<td>1,213</td>
<td>1,228</td>
<td>1.24</td>
</tr>
<tr>
<td>Cape Addington</td>
<td>6/28/2000</td>
<td>16:26</td>
<td>1,116</td>
<td>1,180</td>
<td>5.73</td>
</tr>
<tr>
<td>Timbered I.</td>
<td>6/28/2000</td>
<td>16:50</td>
<td>267</td>
<td>287</td>
<td>7.69</td>
</tr>
<tr>
<td>Hazy I.</td>
<td>6/28/2000</td>
<td>17:18</td>
<td>1,824</td>
<td>1,885</td>
<td>3.34</td>
</tr>
<tr>
<td>SW Brother</td>
<td>6/28/2000</td>
<td>18:12</td>
<td>1,499</td>
<td>1,461</td>
<td>-2.50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>14,706</td>
<td>15,159</td>
<td>3.08</td>
</tr>
<tr>
<td>Average of site by site % differences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.19</td>
</tr>
</tbody>
</table>
Table 3.--Counts of adult and juvenile (non-pup) Steller sea lions observed at trend rookeries, 1970s and 1990s trend sites, and at all surveyed (surv.) sites in the Kenai-to-Kiska area and throughout the western stock in Alaska during June and July aerial surveys from 1985 to 2004. Also shown are overall percent changes between various pairs of years, and estimated annual rates of change between 1991 and 2000 and between 2000 and 2004. Annual rates of change that are significantly different from zero (P < 0.05) are shown in bold. Totals at trend sites in 2004 (*) have been adjusted to account for film format-count differences (see text).

<table>
<thead>
<tr>
<th>Year</th>
<th>Kenai-to-Kiska Index Area</th>
<th></th>
<th>Western Stock in Alaska</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>39,390</td>
<td>54,738</td>
<td>67,336</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>18,791</td>
<td>22,754</td>
<td>26,219</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>17,181</td>
<td>21,726</td>
<td>27,149</td>
<td>27,454</td>
</tr>
<tr>
<td>1992</td>
<td>16,577</td>
<td>20,692</td>
<td>25,811</td>
<td>26,970</td>
</tr>
<tr>
<td>1994</td>
<td>14,536</td>
<td>18,736</td>
<td>24,796</td>
<td>25,997</td>
</tr>
<tr>
<td>1996</td>
<td>13,902</td>
<td>17,891</td>
<td>23,091</td>
<td>24,603</td>
</tr>
<tr>
<td>1998 **</td>
<td>12,116</td>
<td>16,417</td>
<td>22,964</td>
<td>24,380</td>
</tr>
<tr>
<td>2000</td>
<td>11,738</td>
<td>15,279</td>
<td>20,101</td>
<td>21,381</td>
</tr>
<tr>
<td>2002</td>
<td>12,893</td>
<td>16,023</td>
<td>21,018</td>
<td>22,221</td>
</tr>
<tr>
<td>2004 *</td>
<td>13,860</td>
<td>17,099</td>
<td>22,137</td>
<td>24,420</td>
</tr>
</tbody>
</table>

Percent change
- 1985-2000: -70.2% -72.1%
- 1985-2004: -64.8% -68.8%
- 1991-2000: -31.7% -29.7% -26.0%
- 1991-2004: -19.3% -21.3% -18.5%
- 2000-2004: 18.1% 11.9% 10.1%

Estimated annual rates of change: 1991 to 2000
- Annual Change: -4.3% -3.8% -2.9%
- +95% CI: -3.4% -3.3% -1.9%
- -95% CI: -5.3% -4.2% -3.9%
- P: < 0.001 < 0.001 < 0.01

32
Table 3. --(Continued)

<table>
<thead>
<tr>
<th>Year</th>
<th>Kenai-to-Kiska Index Area</th>
<th>Western Stock in Alaska</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.2%</td>
<td>2.9%</td>
</tr>
<tr>
<td></td>
<td>8.4%</td>
<td>6.2%</td>
</tr>
<tr>
<td></td>
<td>0.2%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.05</td>
<td>&gt; 0.05</td>
</tr>
</tbody>
</table>

Estimated annual rates of change: 2000 to 2004

For eastern Gulf of Alaska in 1998, counts made in 1999 were substituted for those sites not surveyed in 1998.
Table 4.—Counts of adult and juvenile (non-pup) Steller sea lions observed at 1970s trend sites in seven sub-areas of Alaska during June and July aerial surveys from 1985 to 2004. Also shown are overall percent changes between various pairs of years and estimated annual rates of change between 1991 and 2000 and between 2000 and 2004. Annual rates of change that are significantly different from zero ($P < 0.05$) are shown in bold. ND = no data. Data shown for 2004(*) have been adjusted to account for film format-count differences (see text).

<table>
<thead>
<tr>
<th>Year</th>
<th>Gulf of Alaska</th>
<th>Aleutian Islands</th>
<th>Western Kenai to Kiska</th>
<th>Stock in AK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eastern</td>
<td>Central</td>
<td>Western</td>
<td>Eastern</td>
</tr>
<tr>
<td>1985***</td>
<td>19,002</td>
<td>6,275</td>
<td>7,505</td>
<td>21,956</td>
</tr>
<tr>
<td>1990</td>
<td>5,444</td>
<td>7,050</td>
<td>3,915</td>
<td>3,801</td>
</tr>
<tr>
<td>1991</td>
<td>4,596</td>
<td>7,050</td>
<td>3,915</td>
<td>3,801</td>
</tr>
<tr>
<td>1992</td>
<td>3,738</td>
<td>5,739</td>
<td>3,915</td>
<td>4,839</td>
</tr>
<tr>
<td>1994</td>
<td>3,365</td>
<td>4,516</td>
<td>3,915</td>
<td>4,419</td>
</tr>
<tr>
<td>1998**</td>
<td>2,110</td>
<td>3,366</td>
<td>4,715</td>
<td>2,860</td>
</tr>
<tr>
<td>2000</td>
<td>1,975</td>
<td>3,180</td>
<td>2,840</td>
<td>3,840</td>
</tr>
<tr>
<td>2002</td>
<td>2,500</td>
<td>3,366</td>
<td>3,221</td>
<td>3,956</td>
</tr>
<tr>
<td>2004*</td>
<td>2,536</td>
<td>2,944</td>
<td>3,512</td>
<td>4,707</td>
</tr>
</tbody>
</table>

** Percent change

| 1985-2000 | -83.3% | -54.7% | -48.8% | -75.3% | -76.3% | -72.1% |
| 1985-2004 | -84.5% | -44.0% | -37.3% | -73.0% | -80.2% | -68.8% |
| 1991-2000 | -57.0% | -49.3% | -23.9% | -9.2%  | -27.7% | -65.3% |
| 1991-2004 | -44.8% | -53.0% | -5.9%  | 11.3%  | -20.8% | -70.9% |
| 2000-2004 | 28.4%  | -7.4%  | 23.7%  | 22.6%  | 9.5%   | -16.1% |

** Estimated annual rates of change: 1991 to 2000**

| Rate   | -9.3%  | -7.4%  | -2.7%  | -1.8%  | -2.9%  | -9.5%  | -3.8%  | -4.9%  |
|        | -51.1% | -5.7%  | 0.2%   | 1.1%   | -0.3%  | -4.0%  | -3.3%  | -4.3%  |
|        | -13.3% | -9.1%  | -5.5%  | -4.7%  | -5.4%  | -14.6% | -4.2%  | -5.5%  |
| P      | < 0.01 | < 0.001| > 0.05 | > 0.10 | < 0.05 | < 0.01 | < 0.001| < 0.001|

** Estimated annual rates of change: 2000 to 2004**

| Rate   | 6.3%   | -1.9%  | 5.3%   | 5.1%   | 2.3%   | -4.4%  | 2.8%   | 2.8%   |
|        | 59.8%  | 39.2%  | 13.3%  | 37.0%  | 16.0%  | 87.0%  | 6.2%   | 4.0%   |
|        | -29.1% | -30.9% | -1.9%  | -19.2% | -9.8%  | -51.0% | -0.4%  | 1.8%   |
| P      | > 0.30 | > 0.60 | > 0.05 | > 0.20 | > 0.20 | > 0.50 | > 0.05 | < 0.05 |

** For eastern Gulf of Alaska in 1998, counts made in 1999 were substituted for those sites not surveyed in 1998.
*** For western Aleutian Islands in 1985, counts made in 1988 were substituted for Buldir.
Table 5.--Counts of adult and juvenile (non-pup) Steller sea lions observed at 1990s trend sites in seven subareas of Alaska during June-July aerial surveys from 1991 to 2004. Also shown are overall percent changes between various pairs of years and estimated annual rates of change between 1991 and 2000 and between 2000 and 2004. Annual rates of change that are significantly different from zero (P < 0.05) are shown in bold. Data shown for 2004(*) have been adjusted to account for film format-count differences (see text).

<table>
<thead>
<tr>
<th>Year</th>
<th>Gulf of Alaska</th>
<th>Aleutian Islands</th>
<th>Kenai to Stock in Western Alaska</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eastern</td>
<td>Central</td>
<td>Western</td>
</tr>
<tr>
<td>1991</td>
<td>4,812</td>
<td>7,872</td>
<td>5,338</td>
</tr>
<tr>
<td>1992</td>
<td>3,981</td>
<td>7,358</td>
<td>5,112</td>
</tr>
<tr>
<td>1994</td>
<td>3,612</td>
<td>6,505</td>
<td>5,718</td>
</tr>
<tr>
<td>1996</td>
<td>2,450</td>
<td>5,400</td>
<td>5,356</td>
</tr>
<tr>
<td>1998**</td>
<td>2,158</td>
<td>4,806</td>
<td>5,367</td>
</tr>
<tr>
<td>2000</td>
<td>2,102</td>
<td>4,555</td>
<td>3,966</td>
</tr>
<tr>
<td>2002</td>
<td>2,615</td>
<td>4,594</td>
<td>4,617</td>
</tr>
<tr>
<td>2004*</td>
<td>3,015</td>
<td>4,028</td>
<td>5,233</td>
</tr>
</tbody>
</table>

Percent change

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gulf of Alaska</td>
<td>-56.3%</td>
<td>-42.1%</td>
<td>-25.1%</td>
</tr>
<tr>
<td>Aleutian Islands</td>
<td>-37.3%</td>
<td>-48.8%</td>
<td>-2.0%</td>
</tr>
<tr>
<td>Kenai to Stock in Western Alaska</td>
<td>43.4%</td>
<td>-11.6%</td>
<td>31.0%</td>
</tr>
</tbody>
</table>

Estimated annual rates of change: 1991 to 2000

| Annual Rate | -9.2% | -6.2% | -2.2% | -0.4% | -2.5% | -9.3% | -2.9% | -4.2% |
| +95% CI     | -5.9% | -5.0% | 1.9% | 2.2% | 0.3% | -4.3% | -1.9% | -3.2% |
| -95% CI     | -12.4% | -7.4% | -6.0% | -2.9% | -5.2% | -14.1% | -3.9% | -5.2% |
| P           | < 0.05 | < 0.001 | > 0.20 | > 0.60 | > 0.05 | < 0.01 | < 0.01 | < 0.001 |

Estimated annual rates of change: 2000 to 2004

| Annual Rate | 9.4% | -3.0% | 7.0% | 4.7% | 1.2% | -5.8% | 2.4% | 2.6% |
| +95% CI     | 25.8% | 25.4% | 10.8% | 20.6% | 11.4% | 90.6% | 3.8% | 6.8% |
| -95% CI     | -4.8% | -25.0% | 3.3% | -9.1% | -8.0% | -53.4% | 1.1% | -1.4% |
| P           | > 0.05 | > 0.30 | < 0.05 | > 0.10 | > 0.30 | > 0.40 | < 0.05 | > 0.05 |

**For eastern Gulf of Alaska in 1998, counts made in 1999 were substituted for those sites not surveyed in 1998.
Table 6.--Counts of adult and juvenile (non-pup) Steller sea lions observed at trend rookeries in seven subareas of Alaska during June-July aerial surveys from 1985 to 2004. Also shown are overall percent changes between various pairs of years and estimated annual rates of change between 1991 and 2000 and between 2000 and 2004. Annual rates of change that are significantly different from zero (P < 0.05) are shown in bold. ND = no data. Data shown for 2004(*) have been adjusted to account for film format-count differences (see text). Number of rookeries in each subarea (n) used in the analysis is shown.

| Year | Gulf of Alaska | | Aleutian Islands | | Western Stock in Alaska | |
|------|----------------|------------------|-----------------|----------------------|------------------|
|      | Eastern n = 2 | Central n = 4 | Western n = 4 | Eastern n = 7 | Central n = 11 | Western n = 3 | Kenai to Kiska | |
| 1985** | ND | 12,379 | 4,888 | 6,406 | 15,717 | 4,526 | 39,390 | |
| 1990 | 2,703 | 5,140 | 3,496 | 3,417 | 6,095 | 2,685 | 17,181 | 22,436 |
| 1991 | 2,570 | 4,336 | 3,234 | 3,516 | 4,769 | 1,907 | 13,902 | 16,855 |
| 1992 | 1,789 | 4,308 | 3,313 | 3,712 | 5,244 | 2,531 | 16,577 | 20,897 |
| 1994 | 1,284 | 3,098 | 3,155 | 3,514 | 4,769 | 1,813 | 14,536 | 17,633 |
| 1996 | 1,046 | 2,795 | 3,029 | 3,538 | 4,540 | 1,907 | 13,902 | 16,855 |
| 1998 | 1,060 | 2,255 | 2,948 | 2,719 | 4,194 | 1,643 | 12,116 | 14,819 |
| 2000 | 1,145 | 2,157 | 2,613 | 2,731 | 4,237 | 915 | 11,738 | 13,798 |
| 2002 | 1,164 | 2,486 | 2,920 | 3,271 | 4,216 | 659 | 12,893 | 14,716 |
| 2004* | 1,314 | 2,133 | 3,277 | 3,725 | 4,725 | 778 | 13,860 | 15,952 |

Percent change

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-82.6%</td>
<td>-82.6%</td>
<td>-57.4%</td>
<td>-73.0%</td>
<td>-79.8%</td>
</tr>
</tbody>
</table>

Estimated annual rates of change: 1991 to 2000

<table>
<thead>
<tr>
<th></th>
<th>Annual Rate</th>
<th>+95% CI</th>
<th>-95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-8.2%</td>
<td>-8.2%</td>
<td>-2.3%</td>
<td>-3.4%</td>
</tr>
</tbody>
</table>

Estimated annual rates of change: 2000 to 2004

<table>
<thead>
<tr>
<th></th>
<th>Annual Rate</th>
<th>+95% CI</th>
<th>-95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.5%</td>
<td>0.3%</td>
<td>5.8%</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

** For western Aleutian Islands in 1985, counts made in 1988 were substituted for Buldir Island.
Table 7.--Counts of Steller sea lion non-pups (adults and juveniles) at principal western stock rookeries in Alaska during June and July surveys, 1985-2004. Counts from 1985 to 2002 were made from 35 mm slides. All counts in 2004 (except Akun-Billings Head: 35 mm) were made from medium-format photographs. Counts in 2004 should not be used for trend analyses at individual sites because of differences in resolution between film formats (see text). Data for haul-out sites where significant number of pups were counted are also shown (*). Italicized rookery names are trend rookeries whose counts are summed in Table 5.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eastern Gulf of Alaska</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seal Rocks</td>
<td>2,159</td>
<td>1,471</td>
<td>1,220</td>
<td>784</td>
<td>636</td>
<td>544</td>
<td>730</td>
<td>624</td>
<td>749</td>
<td>768</td>
<td>841</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish (Wooded)</td>
<td>1,333</td>
<td>1,232</td>
<td>1,350</td>
<td>1,005</td>
<td>648</td>
<td>502</td>
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* Haul-out sites where pups have been observed.
Table 8.--Counts of Steller sea lion pups at principal western stock rookeries in Alaska during June and July surveys, 1985-2004. Count-type refers to method of counting pups: OS = on-site - pups counted after adults moved from area, from a skiff/ship nearby, or from an observation point on-land; MF= pups counted from medium-format aerial photographs. Counts at italicized rookeries highlighted in bold were used for time period/sub-area summaries in Table 9. Data for haul-out sites where significant numbers of pups have been counted are also shown (*).

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Table 8. --(Continued).

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2. 1994 Bogoslof count is mean of 1993 and 1995 counts.
Table 9.-- Counts of Steller sea lion pups at selected rookeries (italicized in Table 7) in seven sub-areas of the western stock in Alaska from 1985-89 to 2003-2004. The maximum count during each period at the selected rookeries (n) was used (bold numbers in Table 8). Blank cells indicate incomplete counts in the period and sub-area. Percentage change in counts between periods is also shown.

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<td>1985-1989</td>
<td>10,254</td>
<td>4,904</td>
<td>9,428</td>
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<td>1990-1992</td>
<td>903</td>
<td>2,831</td>
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<td>1994</td>
<td>611</td>
<td>1,876</td>
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<tr>
<td>1997</td>
<td>689</td>
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<tr>
<td>1998</td>
<td>716</td>
<td>1,609</td>
<td>1,577</td>
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<td>2001-2002</td>
<td>586</td>
<td>1,721</td>
<td>1,671</td>
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<td>2003-2004</td>
<td>716</td>
<td>1,609</td>
<td>1,577</td>
</tr>
</tbody>
</table>

Percent Change
1985-89 to 2001-2002: -83.2% -67.3% -72.3%
1990-92 to 2001-2002: -64.9% -13.1% -26.2% -26.8% -39.5%
1998 to 2001-2002: -14.9% -8.3% 11.9% 5.9% -7.8% -39.2% -1.5% -5.8%
1998 to 2003-2004: 3.9% -14.2% 5.6% 17.4%
2001-2002 to 2003-2004: 22.2% -6.5% -5.6% 10.9%

* 1985-89 CAI count does not include Amchitka/Column Rocks (n = 10).
Table 10.--Steller sea lion pup counts from medium-format (vertical) photographs and from the beach at the same sites, 1998-2002. Counts were made 1-4 days apart (Time Diff relative to the beach count). The percent difference (Percent Diff) for each site is calculated with the medium-format count relative to the beach count.

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<tr>
<th>SITENAME</th>
<th>Time Diff (days)</th>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Count</th>
<th>Medium Format (MF)</th>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Count</th>
<th>Beach (B)</th>
<th>Count Diff (MF-B)</th>
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<td>29</td>
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<td>2002</td>
<td>6</td>
<td>25</td>
<td>160</td>
<td></td>
<td>-9</td>
<td>-6.0%</td>
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</table>

ADAK/LAKE POINT                  1   2002 | 6   | 30  | 354 | 2002 | 6   | 29  | 363 | -10 | -2.7%   |
KASATOCHI/NORTH POINT            2   2002 | 6   | 30  | 289 | 2002 | 6   | 28  | 302 | -13 | -4.5%   |
THE WHALEBACK                    3   2002 | 7   | 2   | 16  | 2002 | 6   | 29  | 16  | 0   | 0.0%    |
OGCHUL                           4   2001 | 6   | 29  | 57  | 2001 | 6   | 25  | 47  | 10  | 17.5%   |

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Figure 1.--Map of Alaska showing the seven population sub-areas used to compile western Steller sea lion survey data, 1970s trend sites used for population analyses, and the principal rookeries (named).
Figure 2.—Comparison of counts of adult and juvenile (non-pup) Steller sea lions made from medium-format and 35 mm images taken at the same site on the same day (Table 2).  A. 35 mm count plotted against medium-format count; 1:1 line also shown.  B. Difference of medium-format and 35 mm counts plotted against the medium-format count; line = medium-format count x 3.64%.
Figure 3.--Number of adult and juvenile (non-pup) Steller sea lions at all surveyed sites, 1970s and 1990s trend rookery and haul-out sites, and trend rookeries in the Kenai-Kiska area (A) and throughout the range of the western stock in Alaska (B). Legend in A also applies to B. Data are in Table 3.
Figure 4.--Number of adult and juvenile (non-pup) Steller sea lions at 1970s trend rookery and haul-out sites in three sub-areas of the Gulf of Alaska (A) and Aleutian Islands (B). Legend in A also applies to B. Data are in Table 4.
Figure 5.—Percent change in number of adult and juvenile (non-pup) Steller sea lions at 1970s trend rookery and haul-out sites by sub-area between 1991 and 2000 (A) and between 2000 and 2004 (B). Data are in Table 4.
Figure 6.--Number of adult and juvenile (non-pup) Steller sea lions at 1990s trend rookery and haul-out sites in three sub-areas of the Gulf of Alaska (A) and Aleutian Islands (B). Legend in A also applies to B. Data are in Table 6.
Figure 7.--Number of adult and juvenile (non-pup) Steller sea lions at trend rookeries in three sub-areas of the Gulf of Alaska (A) and Aleutian Islands (B). Legend in A also applies to B. Data are in Table 5.
Figure 8.--Number of Steller sea lion pups counted at rookeries in each of three sub-areas of the Gulf of Alaska (A) and Aleutian Islands (B). Legend in A also applies to B. Data are in Table 9. Data for pooled groups of years are plotted at the mid-point (e.g., 1985 to 1989 plotted at 1987; 2001 and 2002 plotted at 2001.5).
Figure 9.—Percent change in number of Steller sea lion pups at rookeries by sub-area between 1990-92 and 2001-2002 (A) and between 2001-2002 and 2003-2004 (B). Data are in Table 9.
Figure 10.—Comparison of Steller sea lion pup counts from medium-format (MF) photographs and from the beach at the same site within 4 days of each other (Table 9). A. Beach count plotted against MF count; 1:1 line also shown. B. Difference between MF and beach counts plotted against the MF count for pairs where the MF survey occurred first (solid squares) and the beach count occurred first (open squares).
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