Colonization and Trends in Sea Lions at a Non-pupping Colony in Glacier Bay, Southeastern Alaska, 1988 to 1998

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ABSTRACT

This paper documents the colonization by Steller sea lions and rapid growth in use of South Marble Island (SMI), a non-breeding colony in Glacier Bay National Park. The trend in use SMI is also compared to published (Calkins et al. 1999) trends in the number of non-pup sea lions throughout southeastern Alaska and to the trend in sea lion pups from the nearest rookery. Four methods for counting sea lions were used: 1) visual counts made from boats, 2) visual counts from an elevated shore site overlooking the haulout, 3) counts from photographs taken from boats, and 4) counts from aerial photographs. Aerial photographs were the most accurate but most costly, while visual counts made by experienced observers were the second most accurate method. Counts from photographs taken from boats also provided a very good index of the number of sea lions present, but as numbers increase they underestimate numbers compared to counts by experienced observers. Visual and photographic counts of sea lions by trained observers on tourboats that approach SMI every day during summer months provide an economical and reliable index of the numbers of animals present. The South Marble Island haulout has not been part of other studies to estimate trend or abundance for southeastern Alaska (Calkins et al. 1999, Loughlin et al. 1992), but its recent growth to high counts of 270 animal in July and more than 500 sea lions in August may make it appropriate for inclusion in such surveys.

Key words: Steller sea lion, *Eumetopias jubatus,* abundance, colonization, Glacier Bay, southeastern Alaska, surveys, trends,

INTRODUCTION

In 1997, Steller sea lions in the western portion of their range (west of Cape Suckling, 144°W) in the North Pacific were downlisted from threatened to endangered status under the Endangered Species Act (U.S. Federal Register 62:24345-24355), due to continued declines that began in the eastern Aleutian Islands and spread to the Gulf of Alaska (Braham et al. 1980, Merrick et al. 1987, Loughlin et al. 1992, NMFS 1995). Since the 1970s the number of sea lions in Alaska declined by approximately 60% (Loughlin et al. 1992). However, the number of Steller sea lions in southeastern Alaska (including Glacier Bay) from the late 1970s into the 1990s is considered stable or increasing (Calkins et al. 1999, Loughlin et al. 1992, NMFS 1995), with the rate of increase appearing to have slowed or leveled off from 1989-1997 (Calkins et al. 1999).

The eastern stock of Steller sea lions, of which southeastern Alaska is a part, ranges west of Cape Suckling to southern California, and it is classified under the ESA as threatened (U.S. Federal Register 62:24345-24355). Declines have been noted at the southern extremes of this range, in central and southern California (Loughlin et al. 1992). The breeding ranges of the western and eastern stocks are fairly discreet, although there is overlap in the non-breeding (winter) distribution of Steller sea lions with young animals ranging further than breeding-age animals (Calkins and Pitcher 1982).

Research on Steller sea lions in southeastern Alaska has primarily focused on animals at three rookeries, or pupping colonies (Forrester Island, White Sisters Island, and Hazy Islands), although 10 summer haulout sites were included with these rookeries in a recent analysis of the population status and trend of Steller sea lions in southeastern Alaska (Calkins et al. 1999). The work reported in this paper documents the colonization and growth in use of South Marble Island, a non-pupping colony in Glacier Bay National Park, from 1988 to 1998. The trend in use of SMI is also compared to published trends in the number of non-pup sea lions throughout southeastern Alaska and to the trend in numbers of pups from the nearest rookery (Calkins et al. 1999).

METHODS

Study Site

Two adjacent rock-ledges along the north end of South Marble Island (SMI) in Glacier Bay National Park, Alaska (Fig. 1) are currently used by Steller sea lions, although use of the northernmost area appears to be greater in fall and winter, while the northeaset ledge is used at least from spring through fall. This haulout is visited by the majority of private and tour boats in Glacier Bay, because it offers rich wildlife viewing opportunities. The southeast shore of the island is used by several species of cliff-dwelling sea birds and the north point has the only Steller sea lion haulout in Glacier Bay proper. In addition, SMI's location in the lower mid-Bay makes it easy to access as tourboats travel to or from either the northeast or northwest arms of Glacier Bay (Fig. 1).

From 1988 to 1998 opportunistic and directed counts of sea lions have been made. We have compiled more than 600 counts from SMI from several different sources, and these sources are described in the following sections.

Opportunistic Counts by NPS Staff, 1988 and 1989

In 1989, Greg Streveler, the NPS Resource Manager at Glacier Bay National Park at that time, summarized opportunistic observations of Steller sea lions at the haulout on South Marble Island (NPS, unpublished report, Gustavus, AK). According to Streveler and two other NPS employees who spent considerable time in the Bay, sea lions were not observed using the haulout prior to 1985. Three counts with specific dates from 1988 and 5 counts from 1989 are mentioned in the report, with additional general information on short periods of time when very low numbers or no sea lions were observed.

The highest number of sea lions in this report was 250 animals on 5 Sept, 1988, and this was a visual estimate made from an airplane by the NPS Superintendent (M. Jensen) at that time. It is important to note that counting sea lions from the air, even for experienced pinniped biologists, is difficult. Consequently, the accuracy of this estimate

is uncertain. Streveler (NPS, unpublished report, Gustavus, AK) speculates that there may have been a brief period of increased use of the SMI haulout by sea lions from 1985 – 1988, and that use may have been reversed based on no animals present during one observation in Sept, 1988 and 3 in August, 1989.

A total of 20 counts, including 8 specific (counts or estimates with exact dates) and 12 extrapolated counts from 1988 and 1989 were used in the database (Table 1). Extrapolated counts were deduced from statements in the report, such as "[d]uring July, [1989] a single animal was hauled out on three days" and "during the first half of August, sea lions were hauled out on most visits, the maximum being 10 on 8/8."

Counts and Estimates by National Park Service Interpreters, 1993-1998

Beginning at least in 1992, a wildlife observation notebook was maintained on one of the tourboats that stopped at SMI for wildlife viewing every day from late May through August or early September. An NPS Interpretive Ranger accompanied every trip, and these individuals entered their sightings of wildlife on preprinted forms. In 1993, we explicitly requested that NPS Interpretive Naturalists on this (and other) tourboats scheduled to approach SMI count the sea lions on the haulout and in the water. This request was made by one of us (EAM) during either an orientation session for all NPS Interpreters or via a written request at the beginning of each season, but it did not involve any on site training. Periodic reminders were posted to encourage the Interpretive Naturalists to conduct and report these counts.

The Interpretive Division at Glacier Bay National Park hires about 20 seasonal employees, and approximately 70-80% of the staff return each year. Because these employees are primarily responsible for providing passengers with information on the natural history of the Park, and there can be from 20 to more than 100 passengers on a tourboat, they are not always able to devote time to a careful count. In addition, we have found that certain individuals are more likely to conduct a systematic count using binoculars, whereas others may only have time for a quick visual estimate.

Given the large number of employees, varying backgrounds, and different approaches to counting or estimating, this data set contains a wide range in apparent accuracy, from reports of “lots of sea lions” to “over 100” to “40-50 sea lions“ to specific, non-rounded numbers (e.g., “19” or “77”). We did not attempt to incorporate any of the qualitative comments (e.g., “lots”) into the database. If a numerical range was provided, we used the midpoint of the range (e.g. 45 sea lions was used if the observer reported “40-50”), and we used the more conservative end of estimates that included qualifiers such as “more than” some number. When there were fewer than about 40 sea lions, most of the numbers reported appear to be from actual counts, rather than estimates.

A total of 361 (336 + 25) visual counts or estimates that could be used in this analysis were reported by NPS Interpretive Rangers (Table 1).

Counts from the Island, 1994, 1995, 1997, 1998

On 5 to 11 days each year in 1994, 1995, and 1997 we observed sea lions as part of a vessel interaction study (Mathews 1996) from an elevated site (ca 50 m) south of and overlooking the SMI haulout (Fig. 1). On these days we counted sea lions every 2 or 3 minutes at least for 20 minutes every 1.5 hours, and we collected data from approximately 07:30 to 19:30 each day. As a way to determine the accuracy of visual and photographic counts from boats, we compared counts that were made from the elevated shore site to those reported by Interpreters and crew on tourboats. Counts were considered for this analysis if they occurred within 30 minutes of one another, and as long as sea lions had not entered the water in response to a disturbance between the two counts. In addition, we included the high count for each of the days when observers were on the island; these maximal counts are used in the trend assessment, and we have made no attempt to correct for higher effort on these days.

In 1998, one of us (JMM) spent 2 to 7 hours at the observation site on 8 days (4, 14, 19, 30 August; 14, 24 September; and 9, 14 October). Counts of sea lions were made approximately every 30 minutes. Effort (in total observation hours) on these days was

less than, but most comparable to, those from the vessel interaction study in 1994, 1996 and 1997.

For all of the counts from the island in 1994 and 1996-1998, we used either *Swarovski* 7 X 42 or *Zeiss* 20 X 60 binoculars most often mounted on a tripod. We also used a three-digit counter to tally numbers on the haulout and in the water.

Visual Counts and Counts from Photographs from a Daily Tourboat, 1994 – 1998

In 1994, we provided the NPS Interpreters on the daily tourboat with a 35 mm SLR camera equipped with a 200 mm lens, and we asked them to take photographs of sea lions on the haulout for later assessment. We also requested that they complete a visual count if they had time. Because the NPS Interpreters' priority while at SMI was to be available to respond to questions from visitors, they often did not have time to take photographs or to make a visual count or record the data. This, coupled with the high variability in NPS staff assigned to the tourboat – a different Interpreter was on board each day, resulted in high variance in count data quality and gaps in coverage. To try to correct some of these problems, in 1995 we instead began working with 1 - 4 of the tourboat crew who volunteered to take on the responsibility of counting and photographing sea lions at SMI. At the beginning of each summer, we spent a few hours training these individuals in how to use the camera and to enter the data on the forms we provided. In 1996, we did not have a dedicated photographer on the tourboat for this project.

From 1994 to 1998 (excluding 1996) there were 156 counts from both a visual count and a count made from photographs taken from the tourboat. To test the accuracy of these methods, these counts were compared by plotting them and by conducting a linear regression on the data.

Counts from Aerial Photographs, 1992-1998

In 1994, 1995, 1997, and 1998 aerial photographs of sea lions on the haulout were taken on a total of 27 days during surveys for harbor seals *(Phoca vitulina)* (Table 1). Most of

these surveys occurred during August, although 5 were in June (1997) and 2 were in July (1998). We used a 35 mm SLR camera equipped with either a 200 mm or 300 mm lens and loaded with color slide film rated at 200 or 400 ASA. Aerial photographs were taken from fixed wing, single engine aircraft at altitudes of about 300 m.

A total of 27 counts of sea lions from aerial photographs were used in the database (Table 1); 17 of these included a simultaneous visual estimate or count made by an observer in the airplane or the photographer, however minimal effort was placed in trying to get accurate visual counts.

Counts of Sea Lions from Photographic Slides

The best slide photographs from each encounter (both tourboat and aerial surveys) were selected for counting and given a quality ranking of 1 – 4 (1 = excellent, 2 = good, 3 = poor). The image quality rating encompassed both the effects of weather conditions (low light or fog) and photograph quality (focus, etc.). The majority of images used were considered excellent or good. For most of the slide images taken from boats we counted sea lions by viewing them under a dissecting microscope. Each slide was counted at least twice, and if the two counts differed by >5%, the sea lions were counted again until two counts were within that range of one another. Those two counts were then averaged. Sea lions in aerial photographs were counted once by projecting them onto a paper-covered wall and penciling a mark on each animal as it was clicked off on a tally counter.

Other Counts

Park Service employees in recent years have conducted opportunistic visual and photographic counts from vessels, and these are incorporated into the database. A few black and white photographs from the NPS whale biologists have also been provided with visual counts. Sea lions from either the contact sheet or the negative were also counted by viewing with a dissecting microscope.

Mean and Maximal Counts of Sea Lions by Month

We plotted the mean and maximal counts of sea lions observed on SMI without corrections for differences in effort between months or years.

Observer Levels for Visual Counts

For each of the visual counts, either from a boat or from shore, I ranked the observer's level of experience according to the following criteria:

1) experienced pinniped observer and counter directly involved in the sea lion project,
2) experienced observer, wildlife biologist, designated tourboat crewmember, or NPS Interpreter known to provide counts rather than estimates
3) other NPS Interpreters or vessel crewmember,
4) inexperienced observer, and
5) experience level unknown

Comparisons of Selected Counting Methods

We compared visual counts made from tourboats to the results from counts of photographs that had been taken at the time of each visual count. Our prediction was that a visual count made by a more experienced observer would tend to produce a more accurate count than that made from the photographic image. This is because the real-time observer can often detect sea lions whose bodies are hidden from view when they move or raise their heads the counter may detect them and include them. In contrast, the person counting from the photographic image does not include most of these animals. To test this assumption we performed a linear regression on visual and photographic counts made by observers rated at level 1 or 2 and compared this to a regression on counts from those rated with a 3 or lower observer level rating.

Comparison of June/July Trends at SMI to Regional Trends

Trends in the number of Steller sea lions in southeastern Alaska have recently been determined using models that control for the effects of the date, time, and tide during surveys (Calkins et al. 1999). The counts used in the published trend analysis of sea lions on rookeries and haulouts were conducted in June and July. As such, we used the counts

from June and July to determine the rate of increase in use, or trend, at SMI. We performed a linear regression on the maximal count obtained in June or July of each year with available data in these months (1989, 1992-1999). The slope of this line was then compared to the trends for non-pups (+1.7%/yr) in southeastern Alaska and to that for pups (+18.5%/yr) at the nearest rookery.

Our analysis did not include the effects of potential covariables, as was done in the Calkins et al. (1999) study. While we recognize that that the lack of corrections for differences in effort and the effects of time of day or tide could affect the calculated trend, we believe that the use of maximal counts provides a meaningful preliminary estimate of the trend at SMI.

RESULTS

Counts of Sea Lions, 1988-1998

Six hundred and fifty-six counts spanning a decade were compiled from NPS files and from our datasets (Table 1). Most counts (467) were visual; and about 1/4 of the counts (174) included a visual count that could be compared to a count made from a photograph taken at the same time (Table 1).

Table 1. Methods used for counting or estimating Steller sea lions at South Marble Island from 1988-1998.

Observer	Platform	Visual/Photo	1988	1989	1992	1993	1994	1995	1996	1997	1998	Subtotals
NPS	Boat	Photo Only					1					1
Interpreter	"	Vis & Photo					24				1	25
	"	Visual		14	27	76	92	6	106	13	2	336
NPS	Aircraft	Photo Only					3	1		4	2	10
Other	"	Vis & Photo						2	3	7	5	17
Staff	"	Visual	1									1

	Boat	Photo Only								1		1
	"	Vis & Photo					1		1	7	2	11
	"	Visual	2	3	2	5	11	7	8	8	5	51
	Land	Vis & Photo									1	1
	"	Visual					11	10		11	6	38
SOA	Boat	Photo Only						1		1	1	3
tourboat	"	Vis & Photo						29		31	60	120
crew	"	Visual						29		7	5	41
		Totals:	3	17	29	81	150	90	118	97	90	656

Mean and Maximal Counts of Sea Lions by Month

The mean (Fig. 2) and maximal (Fig. 3) counts of sea lions observed on SMI indicate that numbers have increased over the 10 year period. In 1998 we observed high counts of 270 animals in July and more than 500 sea lions in August, compared to fewer than 100 animals in 1988 and 1989. There is also evidence for reduced use of the haulout in mid-summer (June/July) in most years (Fig. 2).

Visual vs. Photographic Counts made from Boats and Observer Level

There were 130 counts by experienced observers ranked as level 1 or 2, and the linear regression on these data indicate that visual counts by the most experienced observers are slightly more accurate than the photographic counts ($y = 18.59 + 0.844x$; $r^2 = 0.81$). When there are fewer than about 50 sea lions, there is a very close match in most visual and photographic counts for these observers (Fig. 4).

We had 34 counts by observers ranked ranked with less experience (level 3 or higher) for which there were counts from photographs for comparison. The regression line for these counts indicates that counts made by observer with less experience tended to be more similar to counts from photographs ($y = 11.253 + 1.068x$; $r^2 = 0.721$) than were counts made by more experienced observers (Fig. 5). This suggests that these observers were

less likely to use as many real-time cues during a visual count as were more experienced observers. (A slope of 1.0 in the regression equation with an $r^2 = 1.0$ would mean that the visual and photographic counts were equal.)

Comparison of Visual Counts from Boats to Counts from an Elevated Shore Site

There were 16 days when we had concurrent counts from the elevated shore site and a tourboat, and the counts from shore were typically higher ($y = 35.288 + 0.455x$; $r^2 = 0.70$), as predicted (Fig. 6).

Trend at SMI Compared to Regional and Local Trends

The rate of increase in the maximal count of sea lions observed during June and July at SMI was significantly higher than that calculated by Calkins et al. (1999) for non-pup sea lions, whereas it was slightly higher than that for pups at White Sisters rookery (Fig. 7).

DISCUSSION

Longterm Trends in Numbers of Sea Lions Using South Marble Island

The increase in use of the Steller sea lion haulout at SMI from 1988-1998 during June and July could be due to one or more of the following:

1. an general increase in the sea lion numbers in southeastern Alaska,
2. high use of the haulout by juvenile sea lions born at White Sisters Island, the nearest rookery,
3. a shift in the distribution or abundance of prey that has made the SMI haulout more favorable for accessing this prey,
4. increasing awareness of the haulout by sea lions, and/or
5. increasing use of the haulout by Steller sea lions from the western population.

Because sea lion numbers in southeastern Alaska have been relatively stable (Calkins et al. 1999) during the decade of growth at SMI, it does not appear that regional trends are driving the increases at SMI. In contrast, the trend in numbers of sea lion pups born at the White Sisters Island rookery – a relatively new rookery – between 1989 and 1997 was +18.5% (Calkins et al.

1999), and this is the closest rookery to SMI. The positive trend observed at SMI during June and July is steeper than that at White Sisters, but it suggests that recently weaned and subadult sea lions from White Sisters could comprise a bulk of the animals responsible for the observed growth in use of the haulout in Glacier Bay. Because the SMI trend is greater than that for the rookery, it is likely that other factors are involved, or that our simple linear regression has biases that make it steeper than it would be if we incorporated appropriate covariables into the analysis. Sea lions branded as pups at the Forrester Island rookery have been oberved at SMI. A physical marking or VHF or satellite tagging study could be conducted to test the hypothesis that a high proportion of sea lions born at White Sisters Island use the SMI haulout in mid-summer.

In Glacier Bay, Steller sea lions are found at three main haulouts, one on South Marble Island, one at Graves Rocks, west of Cape Spencer, and on a few rocks outside of Lituya Bay, along the outer coast. In 1999, biologists from the Alaska Department of Fish and Game observed at least 30 pups at Graves Rocks haulout. Although confirmation is pending, this observation suggested that Graves Rocks is a new rookery. If this is correct, we might expect additional use of the SMI haulout as more pups are born nearby.

It is also possible that the use of SMI as a haulout in mid-summer has increased due to a shift in prey abundance or distribution, perhaps as a result of changes in the marine climate. Sydeman and Allen (Sydeman and Allen 1999) postulate that warming trends in the California Current may be partially responsible for declines in Steller sea lions through the negative effects such temperature regimes have on zooplankton (Roemmich and McGowan 1995). However, very little is known about the diet or foraging behavior of sea lions in Glacier Bay, let alone the potential interactions between their prey and the marine environment.

Steller sea lions are long-lived (females to 30 yrs; males to 18 yrs) (Pitcher and Calkins 1981), gregarious mammals that have very strong site fidelity for breeding sites (Calkins and Pitcher 1982, Kenyon and Rice 1961) and for haulouts (pers. observ.). When a new haulout is colonized, as SMI was in the mid 1980s, it may simply take time for sea lions in the area to learn about it.

The final factor, increasing use by Steller sea lions from the western population seems highly unlikely for two reasons. First, the western population has been declining steeply since about the mid-1970s (Loughlin et al. 1992, Merrick et al. 1987a, York 1994). Second, sea lions have strong site fidelity for rookeries and haulouts during the breeding season – the period when we

documented increasing use of the haulout (Fig. 2). We would expect that even subadults and non-breeding adult sea lions from the western population would remain close to their breeding sites. However, we have observed branded or tagged sea lions from the western population, including one tagged sea lion from Marmot Island, in the Gulf of Alaska, and two branded sea lions from the coast of Russia. The two animals from Russia were observed in late July.

Within Season Trends in Sea Lions at SMI

In each year for which we have data between May or June and at least September, we have observed either a decline in mean counts during June and or July followed by a notable increase in the numbers beginning in August (Fig. 2). In three of the years (1994-1996) since we initiated daily monitoring, there were no sea lions on the haulout for several days in July. The reason for decline in numbers using the haulout from early to mid-summer is not known. One hypothesis is that sea lions temporarily relocate during July to be closer to concentrations of prey.

The most likely explanation for the increased use of the haulout after July is that breeding territories are being abandoned and animals are dispersing from the rookeries. Males become sexually mature at between 3 and 7 years ((Pitcher and Calkins 1981). Steller sea lions are highly polygynous, and the probability of gaining a territory is very low for males younger than 9 years of age (Thorsteinson and C.J. 1962). Subadult and adult males that cannot hold a breeding territory are usually excluded from the rookery. During the spring and summer these non-breeding males, along with a few females, are found at non-breeding haulouts (Belkin 1966). In Alaska breeding territories are established in early May and held through approximately mid June. Females with a yearling come into estrus 11-12 days after giving birth (Hoover 1988), and most mating occurs between late May and early July (Hoover 1988). The increase in numbers of sea lions that we have observed in mid July and August is most likely a result of the dissolution of breeding territories.

A second, non-mutually exclusive explanation for the increase in numbers on SMI after the breeding season is that a shift in prey abundance or distribution may be occuring (or have occurred). Several species of salmon *(Onchorhynchus spp.)* migrate in waters along

the outer coast of Glacier Bay and into Cross Sound and Icy Strait. Sea lions that are feeding on these salmon may leave the SMI haulout for other haulouts closer to prey concentrations. We currently have no information on where sea lions at SMI are feeding, other than salmon trolling gear entanglements (unpublished data) that occur mainly in July and August.

Comparison of Counting Methods

Four methods for counting sea lions were used in this study: 1) visual counts made from boats, 2) visual counts from an elevated shore site overlooking the haulout, 3) counts from photographs taken from boats, and 4) counts from aerial photographs. Counts from aerial photographs are clearly the most accurate, but they are much more costly to obtain than counts from vessels. As such, we recommend that they be used to verify counts from other methods, rather than as the primary method for obtaining daily counts.

Counts of sea lions from vessels appear to provide a reasonable index of the number of sea lions present, but experienced observers produce more accurate counts when there are more than about 50 animals. We recommend that observers who collect data for this project receive more training and verification of their counts. This could be accomplished by having them count sea lions from the island and from the boat for several days with an experienced observer at the beginning of the season. Three or four aerial photographic surveys could also be used to verify the accuracy and precision of trained observers' counts at the beginning, middle and end of the season.

Conclusion

South Marble Island haulout has not been part of other studies to estimate trend or abundance for southeastern Alaska (Calkins et al. 1999, Loughlin et al. 1992). Its recent steep growth during the breeding season to maximal counts of more than 260 sea lions, and to more than 500 animals at other times of the year, may make it worthy of consideration for such inclusion.

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Table 1. Methods used for counting or estimating Steller sea lions at South Marble Island from 1988-1998.

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NPS	Aircraft	Photo Only					3	1		4	2	10
Other	"	Vis & Photo						2	3	7	5	17
Staff	"	Visual	1									1
	Boat	Photo Only								1		1
	"	Vis & Photo					1		1	7	2	11
	"	Visual	2	3	2	5	11	7	8	8	5	51
	Land	Vis & Photo									1	1
	"	Visual					11	10		11	6	38
SOA	Boat	Photo Only						1		1	1	3
tourboat	"	Vis & Photo						29		31	60	120
crew	"	Visual						29		7	5	41
		Totals:	3	17	29	81	150	90	118	97	90	656

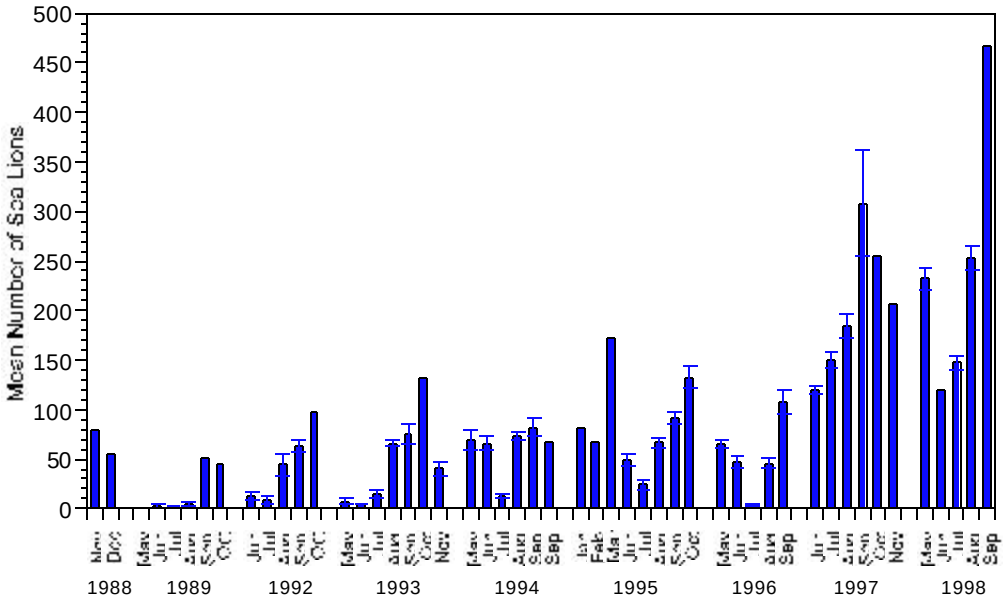


Figure 2. Mean number of Steller sea lions counted from boats at South Marble Island, Glacier Bay, Alaska in 1988, 1989, and 1992-1998. Counts used are from all methods of counting. Error bars are one standard error around the mean.

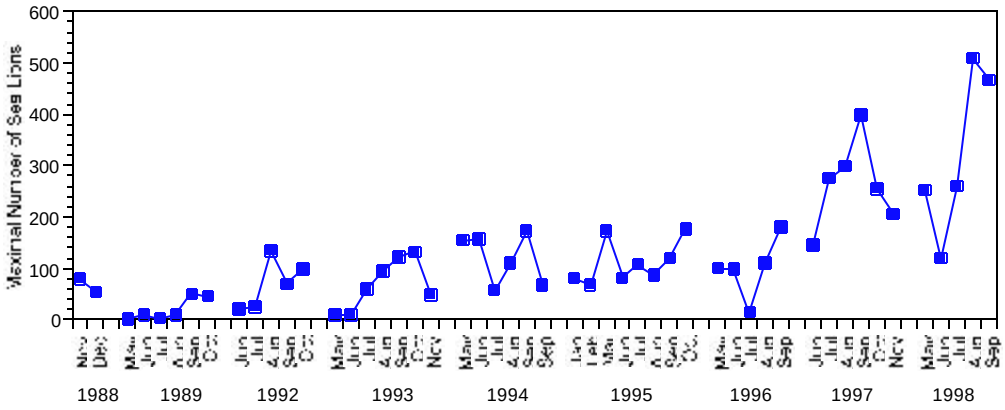


Figure 3. Maximal number of Steller sea lions counted each month from boats at South Marble Island, Glacier Bay, Alaska in 1988, 1989, and 1992-1998. Counts are not corrected for effort or different methodologies.

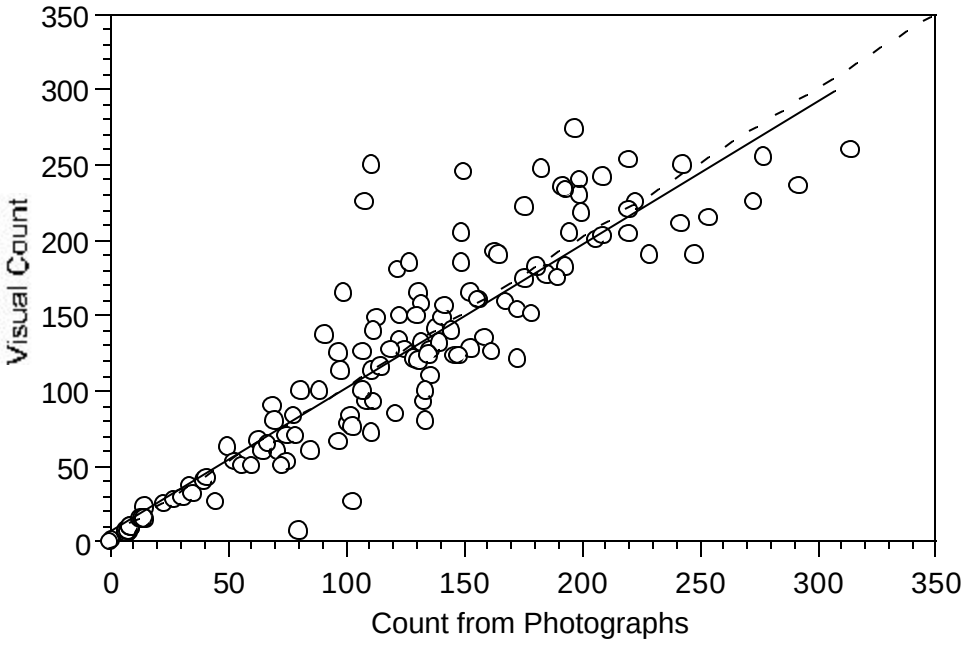


Figure 4. Counts of Steller sea lions from photographs taken at the same time as visual counts made by an experienced observer (level 1 and 2). The solid line is the regression line on the data ($y = 6.927 + 0.957x$, $r2 = 0.797$), while the dashed line is where $x = y$.

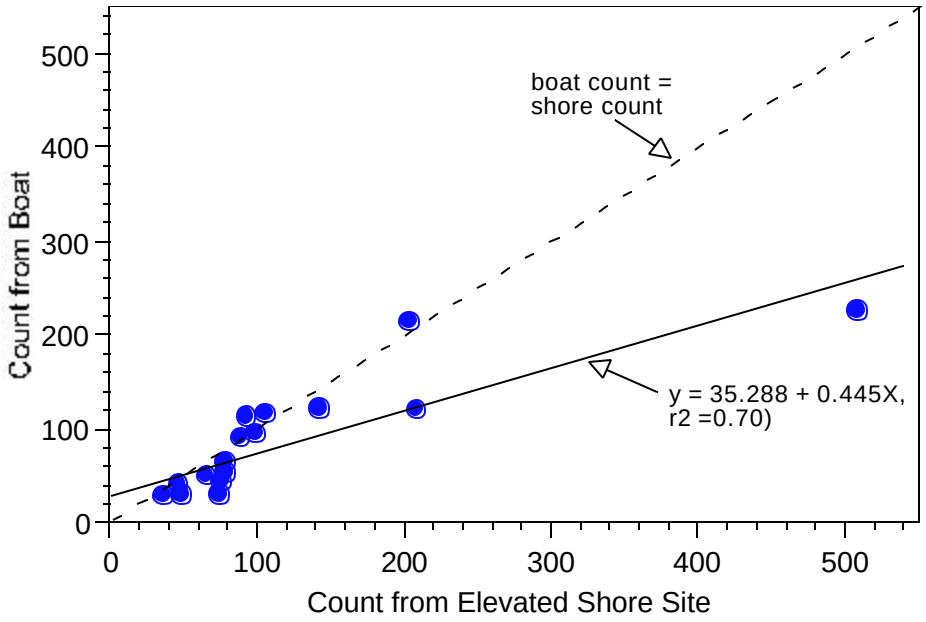


Figure 6. Simultaneous counts of Steller sea lions made by observers from an elevated shore site overlooking the haulout compared to counts made from a tourboat near the haulout. A linear regression of the data (solid line) indicates that shore observers tend to count more of the sea lions present than do observers from the boat. The dashed line has a slope of 1 and points on it are where the two counts were the same.

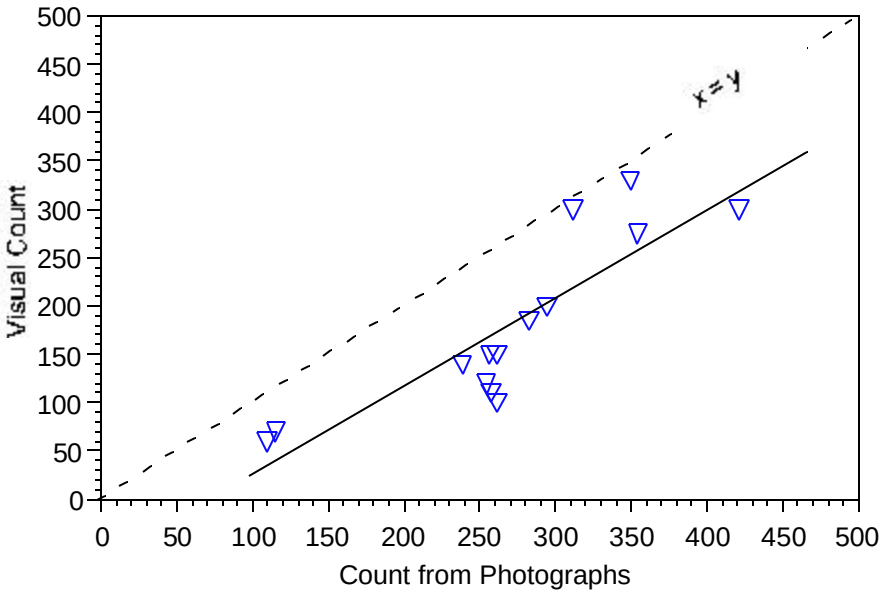
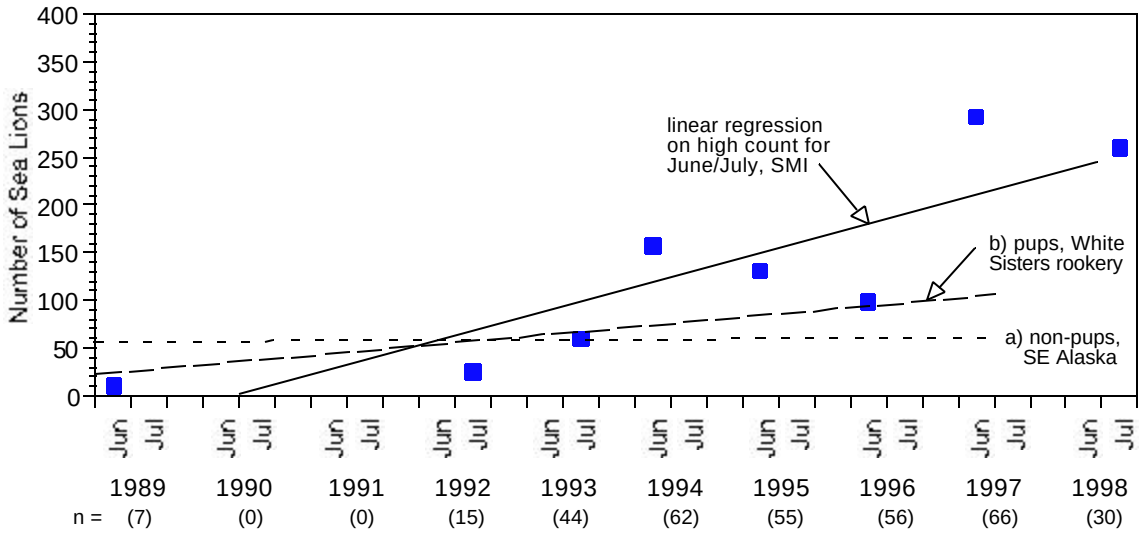


Figure 7. Comparison of visual estimates of numbers of Steller sea lions on a haulout from an aircraft to counts made from photographs taken within one hour*** (n = 14). The solid line is a linear regression on the data (y = -73.2 + 0.934x, r^2 = 0.747), and the dashed line is where concurrent counts would be equal.


Number of Sea Lions
400
350
300
250
200
150
100
50
0
linear regression
on high count for
June/July, SMI
b) pups, White
Sisters rookery
a) non-pups,
SE Alaska
Jun
Jul
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
n =
(7)
(0)
(0)
(15)
(44)
(62)
(55)
(56)
(66)
(30)