



NOAA Technical Memorandum NMFS-AFSC-226

## **Fur Seal Investigations, 2008-2009**

by  
J. W. Testa (editor)

**U.S. DEPARTMENT OF COMMERCE**  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Alaska Fisheries Science Center

May 2011

## NOAA Technical Memorandum NMFS

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This document should be cited as follows:

Testa, J. W. (editor). 2011. Fur seal investigations, 2008-2009. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-226, 80 p.

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## Fur Seal Investigations, 2008-2009

by  
J. W. Testa (editor)

National Marine Mammal Laboratory  
Alaska Fisheries Science Center  
c/o Biological Sciences  
University of Alaska Anchorage  
3211 Providence Drive  
Anchorage AK 99508  
*www.afsc.noaa.gov*

### **U.S. DEPARTMENT OF COMMERCE**

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May 2011

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## ABSTRACT

Researchers from the Alaska Fisheries Science Center's National Marine Mammal Laboratory conduct field investigations on the population status of northern fur seals (*Callorhinus ursinus*) on the Pribilof Islands, Bogoslof Island in the eastern Bering Sea, and on San Miguel Island off the coast of California. This report summarizes these monitoring efforts.

In 2008 and 2009, population parameters monitored on the Pribilof Islands included the size of the subsistence harvest and the number of adult male fur seals. Counts on St. Paul Island yielded totals of 4,119 and 4,121 territorial male seals with females in 2008 and 2009, respectively. On St. George Island the respective totals were 805 and 873. On St. Paul Island, 322 and 341 subadult male seals were harvested in 2008 and 2009, respectively. On St. George Island the respective totals were 170 and 113 subadult male seals. The estimate for the total number of pups born in 2008 was 102,674 (SE = 1,084) on St. Paul Island (not including 6,741 pups born on Sea Lion Rock) and 18,160 (SE = 288) on St. George Island. Pup mortality from birth to late August was 5.3% on St. Paul Island and 5.4% on St. George Island. The number of pups born on St. Paul Island in 2008 was 6.6% less than in 2006 ( $P < 0.01$ ), while at St. George the number of pups increased 1.2% from 2004 to 2006 and 6.4% from 2006 to 2008. Both male and female pups on St. George Island were significantly heavier than those on St. Paul Island ( $P < 0.01$ ), but only males were significantly longer ( $P < 0.01$ ).

Index counts of territorial bulls on San Miguel Island, California, in 2008 and 2009 were 154 and 116, respectively. Estimates of pup production in recent years have been revised to incorporate more realistic mortality estimates. In 2008 and 2009, total numbers of pups born at

San Miguel Island and nearby Castle Rock were 2,914 (SE = 58) and 3,117 (SE = 20), respectively. Pup mortality in recent years has been high, and remained so in 2008 (38%) and 2009 (82%), and appears to be driven by a high incidence of hookworm. Pup weights in both 2008 and 2009 were lower than the long-term average seen at San Miguel Island. Pup production and bull counts remain below the peaks recorded in 1997, just prior to a strong El Niño event, and evidence of recovery since that time has been sporadic.

The estimated stock size for all fur seals breeding in the United States was ~687,000, with the Pribilof Islands population accounting for ~608,000.

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## INTRODUCTION

by

J. Ward Testa

The northern fur seal (*Callorhinus ursinus*) population in the Pribilof Islands Archipelago (on St. Paul and St. George Islands, Figs. 1-3) makes up approximately 50% of the world population. Smaller breeding colonies are located on the Kuril and Commander Islands in Russia, Bogoslof Island (Figs. 1 and 4) in the southeastern Bering Sea, and San Miguel Island (Fig. 5) off California. The rookeries at San Miguel and Bogoslof Islands probably originated in the late 1950s (DeLong 1982) and 1980 (Lloyd et al. 1981), respectively.

Northern fur seals were placed under international management in 1911 under the Treaty for the Preservation and Protection of Fur Seals and Sea Otters between the United States, Russia, Japan, and Great Britain after over a century of commercial exploitation (Gentry 1998). The major population concentration on the Pribilof Islands has been monitored since that time, primarily by counting of territorial adult males and newborn pups on the rookeries. The population grew rapidly from 1911 (possibly 5-8%/year) until the late 1930s, and remained at high levels throughout the 1940s and 1950s. Japan abrogated the convention in 1941, and a new convention was signed in 1957 that called for commercial harvest of adult female fur seals to reduce population size and, according to theory, maximize productivity of the population for commercial harvest. The population declined under that harvest from 1958 to 1968, but productivity did not increase. After a brief rebound in the early 1970s, the population declined further. At St. Paul Island the population fluctuated for two decades at 35-45% of its peak numbers, while the smaller population at nearby St. George has declined at a more or less steady

rate to less than 30% of the peak. Commercial harvesting of fur seals was discontinued on St. George Island in 1973 and on St. Paul Island in 1984, but a small subsistence harvest of juvenile males continues on both islands. There is no subsistence or commercial harvest on the remaining U.S. rookeries.

Northern fur seals were designated as depleted in 1988 under the Marine Mammal Protection Act. This report is part of an ongoing effort by the Alaska Fisheries Science Center's National Marine Mammal Laboratory (NMML) to monitor the status of northern fur seals on U.S. rookeries and to disseminate that information. Research by the NMML on northern fur seals in 2008 and 2009 was conducted under Marine Mammal Protection Act Permit No. 782-1708-00.

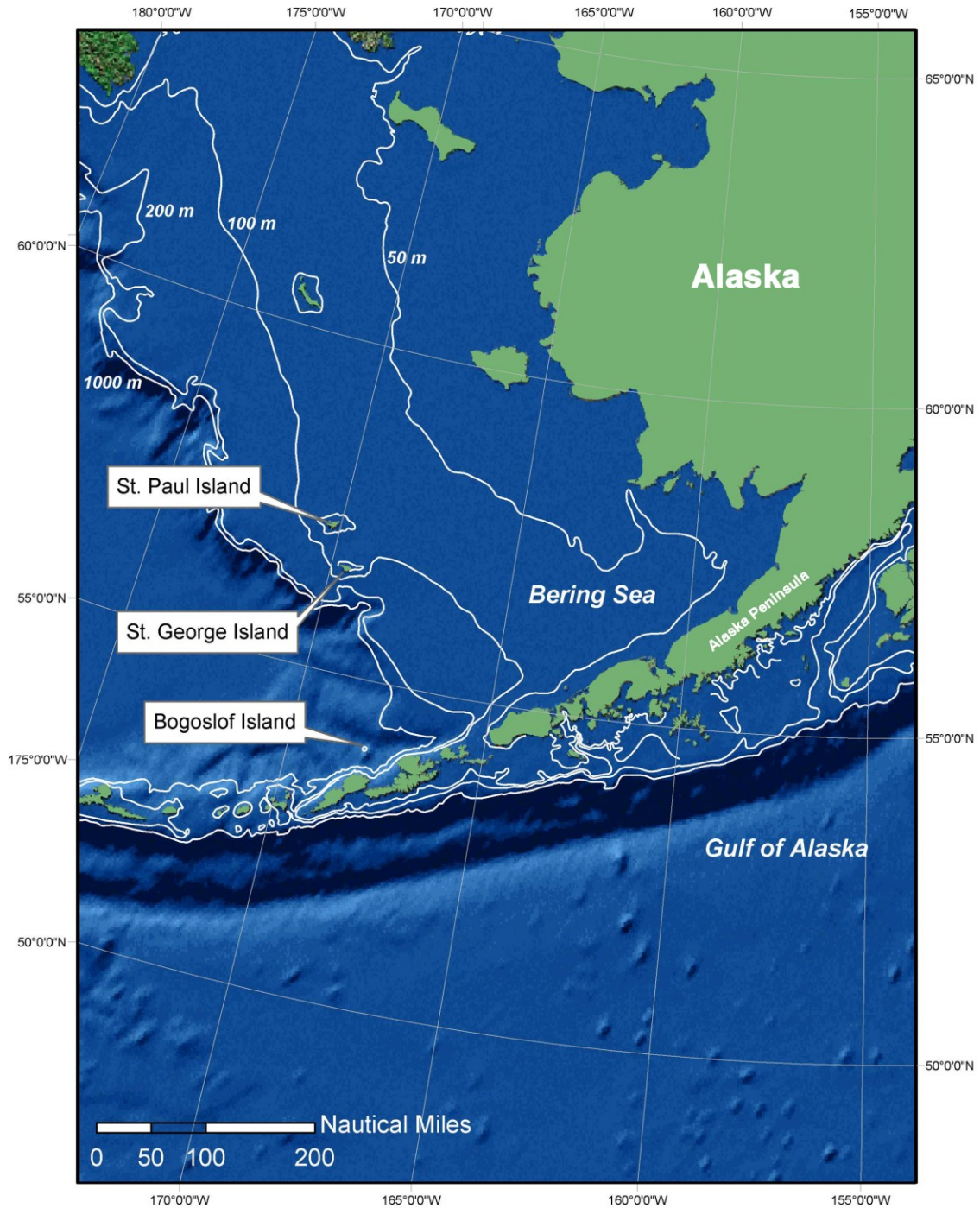


Figure 1.-- Location of the three northern fur seal breeding areas within U.S. Alaskan waters.



Figure 2.-- Location of northern fur seal rookeries on St. Paul Island, Alaska.

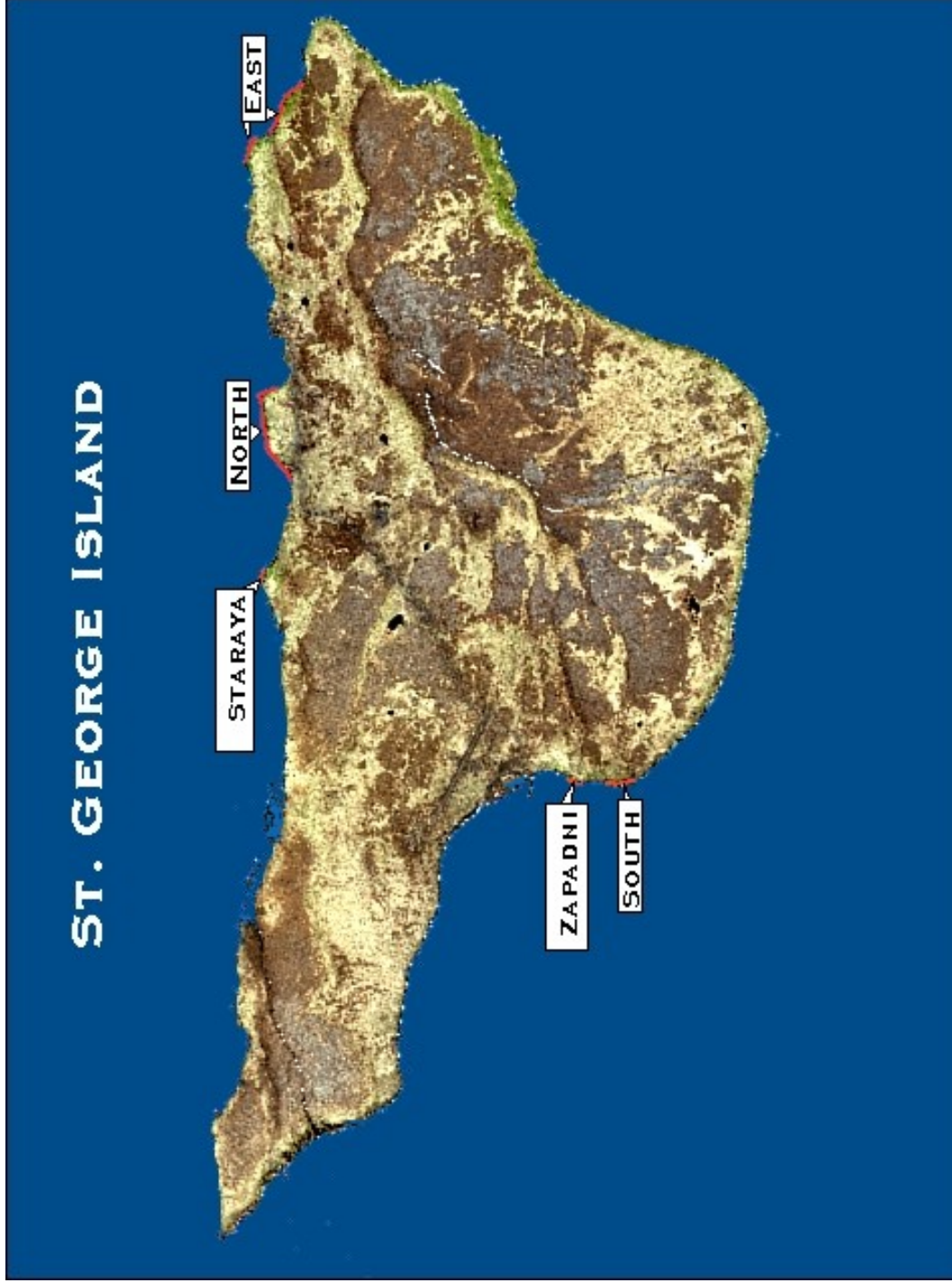


Figure 3.-- Location of northern fur seal rookeries on St. George Island, Alaska.

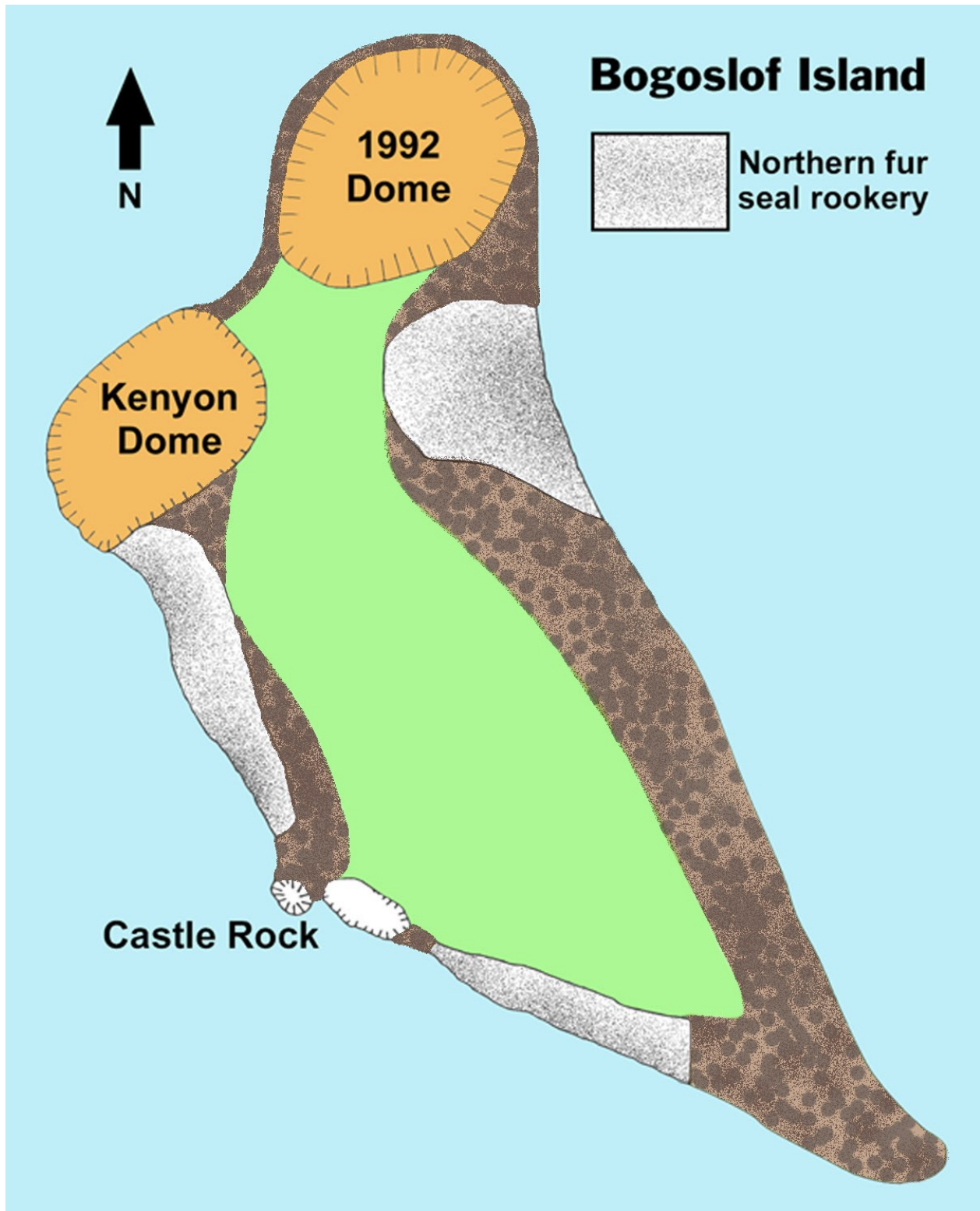


Figure 4.-- Location of northern fur seal rookeries on Bogoslof Island, Alaska.

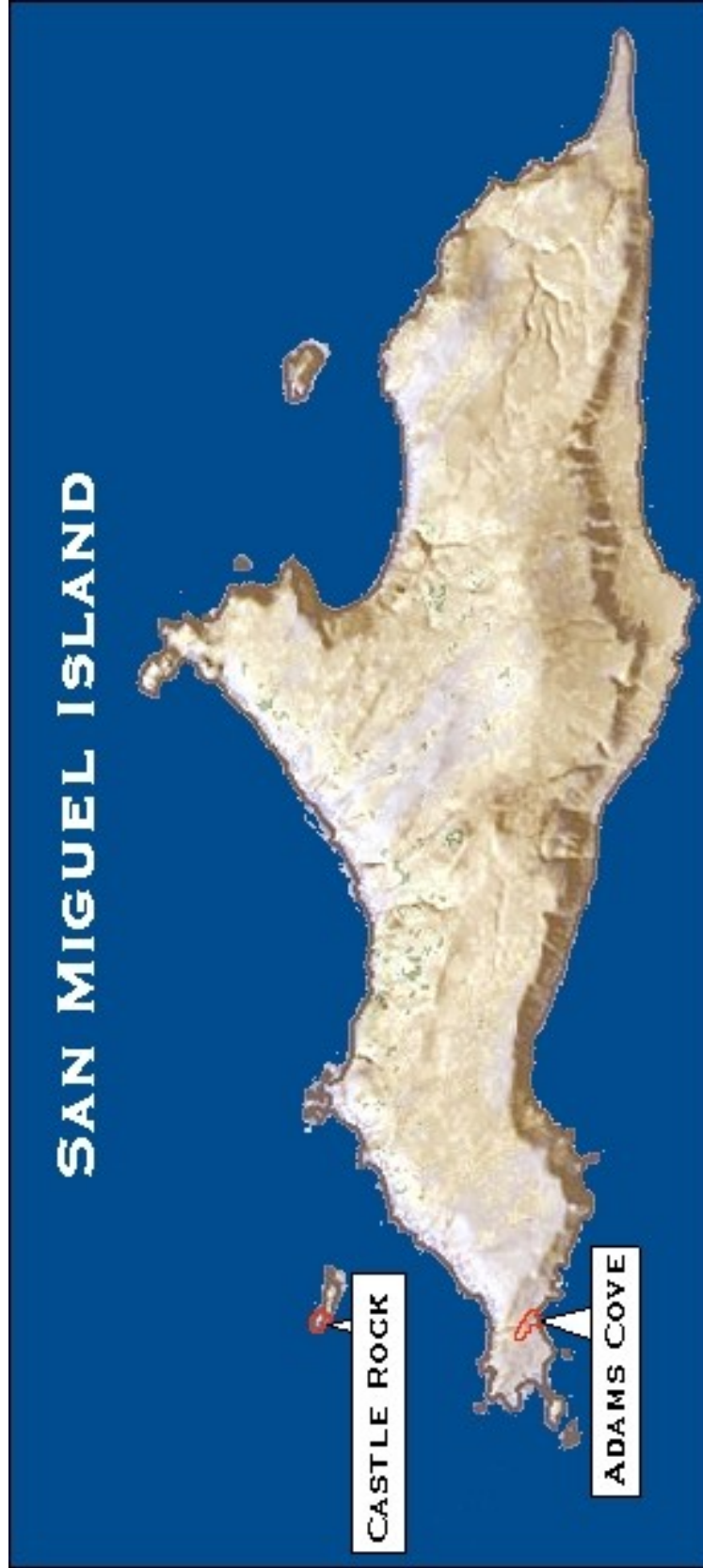


Figure 5.-- Location of northern fur seal rookeries on San Miguel Island, California.

POPULATION ASSESSMENT OF NORTHERN FUR SEALS  
ON THE PRIBILOF ISLANDS, ALASKA, 2008 - 2009

by

Rodney G. Towell, Rolf R. Ream, Jeremy T. Sterling,

Michael Williams, and John L. Bengtson

In accordance with provisions originally established by the Interim Convention on Conservation of North Pacific Fur Seals and to inform management decisions of the National Marine Fisheries Service, the National Marine Mammal Laboratory (NMML) continues to monitor the status of fur seal populations on the Pribilof Islands. To meet these objectives, data on population size, age and sex composition, and natural mortality are collected annually following the methods described by Antonelis (1992).

METHODS

Population characteristics monitored in 2008 on St. Paul and St. George Islands included the size of the subsistence harvest, numbers of adult males and pups, and mortality rates of fur seal pups. Only the subsistence harvest and counts of adult males were monitored in 2009. The subsistence harvest was monitored for the number of juveniles killed for consumption; any other fur seals inadvertently killed, injured or compromised (e.g., hyperthermia) by harvest activities; harvest waste; entanglement; and any unusual conditions among animals on targeted haulouts. Monitoring on St. Paul Island was conducted and reported by staff from the St. Paul Island Tribal Government's Ecosystem Conservation Office and a board-certified veterinarian, both under contract with the National Marine Fisheries Service (NMFS). The St. George Island Kayumixtax






Eco-Office, also under contract with NMFS, monitors and reports the subsistence harvest of northern fur seals on St. George Island.

Adult male fur seals were visually counted by section for each rookery on St. Paul Island from 9 to 15 July 2008 and 8 to 14 July 2009 (Appendix Tables B-1 and B-2, respectively) and on St. George Island from 8 to 11 July 2008 and 12 to 14 July 2009. We report territorial males with (Class 3) and without (Class 2) females on the rookeries, and males on hauling grounds (Class 5, see Appendix A glossary for definitions of terms and Figure 6 for illustration of a typical fur seal rookery).

On St. Paul Island, dead fur seal pups were counted on four sample rookeries and the numbers of live pups were estimated on 13 rookeries in August 2008 using the shearing-sampling method (York and Kozloff 1987, Antonelis 1992). Tooth samples (usually canines) were collected from dead fur seals older than pups whenever possible. Additionally, sample rookeries and adjacent beaches of St. Paul and St. George Islands were surveyed for dead fur seals older than pups during dead pup counts in August 2008. The total number of pups born was estimated using ratio estimation (Cochran 1977). From 7 to 13 August, pups were marked by shearing the guard hairs on top of the head to make the lighter colored underfur conspicuous to observers later. The number of pups sheared on each rookery was approximately 10% of the last estimate of pup production for the sample rookeries in 2006. Shear marks were allocated proportionally on each rookery by section (Appendix Table B-3) according to the fraction of the rookery total for breeding males counted in each section of the sampled rookery. The ratio of marked to unmarked pups was determined by two observers scanning (with the aid of binoculars when necessary) on two occasions for each rookery from 14 to 27 August. Each observer counted

### CLASSES OF ADULT MALES

1. TERRITORIAL WITHOUT FEMALES 
2. TERRITORIAL WITH FEMALES 
3. HAULING GROUND 

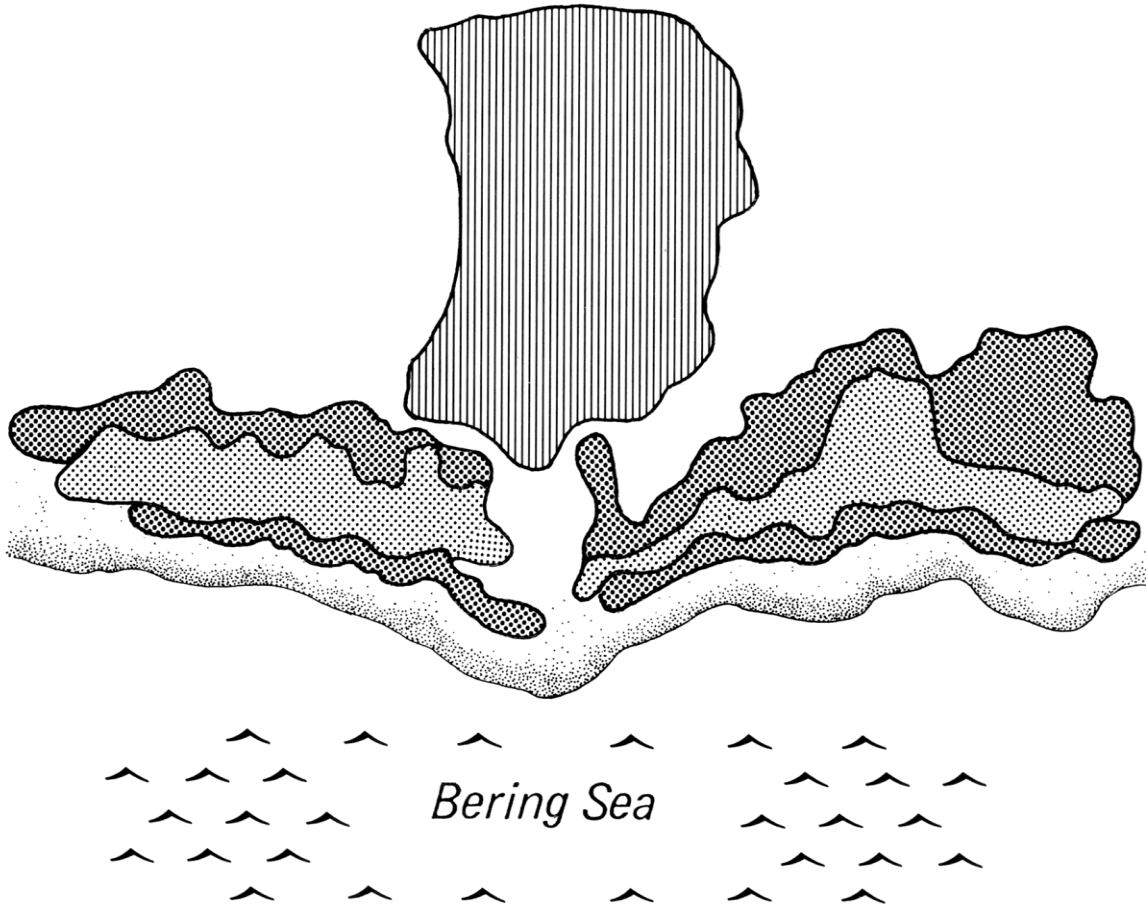


Figure 6.-- The relative location of the different classes of adult males for a typical fur seal rookery/haul-out complex.

marked and unmarked pups independently to ensure that the entire rookery was well sampled. Each sampling day was considered an independent replicate; the variance was computed for each rookery based on these replicates (York and Kozloff 1987). Little Polovina rookery was not sampled due to the concern that this small rookery might be more sensitive to disturbance. We estimated the number of pups born on Little Polovina rookery from a regression of total pups born versus numbers of breeding adult males. By assuming that the pup mortality on Little Polovina rookery was equal to the observed rate on the other rookeries, we estimated the number of dead pups as the product of that mortality rate and the estimate of total pups born. Dead pups were counted from 17 to 20 August on four rookeries. The estimated variance for total pups born was calculated using ratio estimation techniques (Cochran 1977).

The number of pups born on St. George Island was estimated from a shearing-sampling study conducted on all rookeries from 16 to 25 August 2008 in the same manner as applied on St. Paul Island. The ratio of marked to unmarked pups on each rookery was determined by two observers from 19 to 21 August and again from 22 to 24 August. Dead pups were counted on three rookeries from 19 to 21 August 2008.

## RESULTS AND DISCUSSION

### Harvest

A total of 322 and 341 subadult male seals were harvested for subsistence on St. Paul Island in 2008 and 2009, respectively (Table 1). On St. George Island, 170 subadult male seals were taken in the subsistence harvest in 2008 and 113 were killed in 2009 (Table 2). Three

Table 1. -- Date, location, and number of subadult male northern fur seals killed in subsistence harvests on St. Paul Island, Alaska, in 2008 and 2009.

| 2008     |               |               | 2009     |               |               |
|----------|---------------|---------------|----------|---------------|---------------|
| Date     | Rookery       | Number killed | Date     | Rookery       | Number killed |
| July 5   | Zapadni       | 26            | July 2   | Zapadni Sands | 50            |
| July 8   | Polovina      | 47            | July 10  | Polovina      | 23            |
| July 14  | Zapadni       | 36            | July 16  | Zapadni Sands | 64            |
| July 15  | Zapadni Sands | 49            | July 24  | Polovina      | 32            |
| August 6 | Polovina      | 30*           | August 5 | Polovina      | 48            |
| August 7 | Zapadni       | 64*           | August 6 | Vostochni     | 45            |
| August 8 | Gorbach       | 80*           | August 7 | Zapadni Sands | 79            |
| Total    |               | 332           |          |               | 301           |

\* Includes 1 female.

Table 2.-- Date, location, and number of subadult male northern fur seals killed in subsistence harvest drives on St. George Island, Alaska, in 2008 and 2009.

| 2008     |         |               | 2009      |         |               |
|----------|---------|---------------|-----------|---------|---------------|
| Date     | Rookery | Number killed | Date      | Rookery | Number killed |
| July 9   | North   | 10            | July 8    | North   | 7             |
| July 16  | Zapadni | 17            | July 13   | Zapadni | 14            |
| July 18  | North   | 19            | July 15   | North   | 15            |
| July 21  | Zapadni | 10            | July 23   | Zapadni | 12            |
| July 28  | Zapadni | 17            | July 29   | North   | 7             |
| July 31  | Zapadni | 24            | July 31   | Zapadni | 13            |
| August 4 | Zapadni | 19            | August 3  | Zapadni | 15            |
| August 6 | North   | 23            | August 5  | Zapadni | 9             |
| August 7 | Zapadni | 10            | August 7* | Zapadni | 22            |
| August 8 | North   | 21            |           |         |               |
| Total    |         | 170           |           |         | 114           |

\* Includes 1 female.

females on St. Paul Island were killed in 2008. One female on St. George Island was killed in the 2009 harvest. All were included as part of the subsistence harvest (Table 2).

#### Adult Males Counted

The number of territorial males with females (Class 3 or harem males) on St. Paul Island increased 15.5% between 2007 and 2009 (Tables 3 and 4; Appendix Table B-4). The count of harem males on St. George Island increased 8.2% between 2007 and 2008, and increased 8.4% between 2008 and 2009 (Tables 3 and 4; Appendix Table B-4). Owing to the larger size of the population on St. Paul Island, the Pribilof Islands total for harem males increased by 15.8% between 2007 and 2009.

#### Number of Pups Born on St. Paul Island in 2008

The estimated total number of pups alive on St. Paul Island at the time of marking in 2008 was 97,171 (SE = 1,022) (Table 5). The number of dead pups were counted by section on four sample rookeries of St. Paul Island and the total estimated dead on all rookeries was 5,503 (Appendix Table B-5). The estimated mortality rate for late August was 5.3% (Table 6). The total number of pups born on St. Paul Island in 2008 was estimated at 102,674 (SE = 1,084; 95% CI = (100,357 – 105,045)). The standard error accounts for variance in the estimation of both live and dead pups. The approximate 95% CI of pups born was computed as a log-normal CI due to the ratio estimation of the total pups born. The above total does not include the pups on Sea Lion Rock.

A total of 567 pups were sheared on Sea Lion Rock on 9 August, 2008. A single sampling of marked to unmarked pups occurred on 16 August, 2008. The estimated number of pups

Table 3.-- Number of adult male northern fur seals counted by rookery and behavior class (2 = territorial without females, 3 = territorial with females, 5 = non-territorial on hauling grounds), Pribilof Islands, Alaska, July 2008 (see Appendix A for descriptions).

| Rookery                         | Date<br>(July) | Class of adult male |       |       | Total |
|---------------------------------|----------------|---------------------|-------|-------|-------|
|                                 |                | 2                   | 3     | 5     |       |
| <b><u>St. Paul Island</u></b>   |                |                     |       |       |       |
| Lukanin                         | 9              | 36                  | 84    | 152   | 272   |
| Kitovi                          | 9              | 65                  | 158   | 167   | 390   |
| Reef                            | 12             | 175                 | 491   | 469   | 1,135 |
| Gorbatch                        | 12             | 73                  | 341   | 428   | 842   |
| Ardiguen                        | 12             | 10                  | 65    | 6     | 81    |
| Morjovi                         | 12             | 109                 | 344   | 463   | 916   |
| Vostochni                       | 13/14          | 155                 | 959*  | 561   | 1,675 |
| Polovina                        | 15             | 22                  | 108   | 139   | 269   |
| Little Polovina                 | 15             | 0                   | 3     | 186   | 189   |
| Polovina Cliffs                 | 15             | 86                  | 386   | 109   | 581   |
| Tolstoi                         | 10             | 157                 | 363   | 271   | 791   |
| Zapadni Reef                    | 9              | 77                  | 146   | 173   | 396   |
| Little Zapadni                  | 10             | 132                 | 241   | 164   | 537   |
| Zapadni                         | 11             | 145                 | 430   | 520   | 1,095 |
| Island total                    |                | 1,242               | 4,119 | 3,808 | 9,169 |
| <b><u>St. George Island</u></b> |                |                     |       |       |       |
| South                           | 8              | 41                  | 166   | 24    | 231   |
| North                           | 10             | 97                  | 264   | 112   | 473   |
| East Reef                       | 11             | 16                  | 66    | 36    | 118   |
| East Cliffs                     | 11             | 44                  | 202   | 80    | 326   |
| Staraya Artil                   | 9              | 14                  | 34    | 64    | 112   |
| Zapadni                         | 9              | 26                  | 73    | 84    | 183   |
| Island total                    |                | 238                 | 805   | 400   | 1,443 |

\* Suspected error in the counts in section 14; see Appendix Table B-1.

Table 4. -- Number of adult male northern fur seals counted by rookery and behavior class (2 = territorial without females, 3 = territorial with females, 5 = non-territorial on hauling grounds), Pribilof Islands, Alaska, July 2009.

| Rookery                         | Date<br>(July) | Class of adult male |       |       | Total |
|---------------------------------|----------------|---------------------|-------|-------|-------|
|                                 |                | 2                   | 3     | 5     |       |
| <b><u>St. Paul Island</u></b>   |                |                     |       |       |       |
| Lukanin                         | 12             | 32                  | 145   | 122   | 299   |
| Kitovi                          | 12             | 47                  | 240   | 159   | 446   |
| Reef                            | 8              | 151                 | 501   | 342   | 994   |
| Gorbatch                        | 11/14          | 150                 | 324   | 465   | 939   |
| Ardiguen                        | 11             | 7                   | 66    | 14    | 87    |
| Morjovi                         | 10             | 122                 | 380   | 352   | 854   |
| Vostochni                       | 10             | 217                 | 727   | 613   | 1,557 |
| Polovina                        | 13             | 29                  | 97    | 231   | 357   |
| Little Polovina                 | 13             | 5                   | 1     | 212   | 218   |
| Polovina Cliffs                 | 13             | 108                 | 342   | 121   | 571   |
| Tolstoi                         | 12             | 133                 | 430   | 204   | 767   |
| Zapadni Reef                    | 9              | 67                  | 175   | 183   | 425   |
| Little Zapadni                  | 9              | 144                 | 273   | 279   | 696   |
| Zapadni                         | 9              | 224                 | 420   | 493   | 1,137 |
| Island total                    |                | 1,436               | 4,121 | 3,790 | 9,347 |
| <b><u>St. George Island</u></b> |                |                     |       |       |       |
| South                           | 12             | 54                  | 178   | 42    | 274   |
| North                           | 14             | 102                 | 305   | 236   | 643   |
| East Reef                       | 13             | 25                  | 84    | 57    | 166   |
| East Cliffs                     | 13             | 42                  | 184   | 143   | 369   |
| Staraya Artil                   | 13             | 14                  | 43    | 33    | 90    |
| Zapadni                         | 12             | 34                  | 79    | 42    | 155   |
| Island total                    |                | 271                 | 873   | 553   | 1,697 |

Table 5.-- Total number of northern fur seal pups sheared, number of pups estimated to be alive at the time of marking (E1 and E2), mean number alive and standard error (SE), on sampled rookeries of St. Paul Island, Alaska, 2008. The SE for the Sea Lion Rock estimate was calculated from the two observers' estimates.

| Rookery          | Sheared | E1     | E2     | Mean   | SE    |
|------------------|---------|--------|--------|--------|-------|
| Lukanin          | 285     | 3,110  | 2,754  | 2,932  | 178.0 |
| Kitovi           | 399     | 3,724  | 3,617  | 3,671  | 53.5  |
| Reef             | 1,383   | 12,533 | 13,569 | 13,051 | 518.0 |
| Gorbatch         | 908     | 9,615  | 8,422  | 9,019  | 596.5 |
| Ardiguen         | 97      | 656    | 794    | 725    | 69.0  |
| Morjovi          | 929     | 7,658  | 7,911  | 7,785  | 126.5 |
| Vostochni        | 1,533   | 15,098 | 14,269 | 14,684 | 414.5 |
| Polovina         | 269     | 2,474  | 2,401  | 2,438  | 36.5  |
| Little Polovina* |         |        |        | 52     | 7.6   |
| Polovina Cliffs  | 1,001   | 8,957  | 8,329  | 8,643  | 314.0 |
| Tolstoi          | 1,139   | 10,705 | 10,718 | 10,712 | 6.5   |
| Zapadni Reef     | 543     | 4,394  | 4,920  | 4,657  | 263.0 |
| Little Zapadni   | 909     | 7,739  | 7,447  | 7,593  | 146.0 |
| Zapadni          | 1,317   | 11,153 | 11,270 | 11,212 | 58.5  |
| Sea Lion Rock    | 567     | 6,380  |        |        | 79.5  |

\* Little Polovina estimated from the regression of live pups on number of harem males.



Table 6.-- Number of pups alive at the time of marking, estimated total pups born, harem males and the ratio of pups alive at marking to harem males, on sampled rookeries of St. Paul Island, Alaska, 2008.

| Sample Rookery  | Pups alive at marking | Total pups born | Harem males | Ratio pups/males |
|-----------------|-----------------------|-----------------|-------------|------------------|
| Lukanin         | 2,932                 | 3,098           | 84          | 36.88            |
| Kitovi          | 3,671                 | 3,879           | 158         | 24.55            |
| Reef            | 13,051                | 13,790          | 491         | 28.08            |
| Gorbatch        | 9,019                 | 9,530           | 341         | 27.95            |
| Ardiguen        | 725                   | 766             | 65          | 11.79            |
| Morjovi         | 7,785                 | 8,226           | 344         | 23.91            |
| Vostochni       | 14,684                | 15,515          | 959*        | 16.18            |
| Polovina        | 2,438                 | 2,576           | 108         | 23.85            |
| Little Polovina | 49                    | 52              | 3           | 17.33            |
| Polovina Cliffs | 8,643                 | 9,132           | 386         | 23.66            |
| Tolstoi         | 10,712                | 11,319          | 363         | 31.18            |
| Zapadni Reef    | 4,657                 | 4,921           | 146         | 33.70            |
| Little Zapadni  | 7,593                 | 8,023           | 241         | 33.29            |
| Zapadni         | 11,212                | 11,847          | 460         | 27.55            |
| St. Paul Total  | 97,171                | 102,674         | 4,119       | 24.93            |
| Sea Lion Rock   | 6,380                 | 6,741           |             |                  |
| Total           | 103,551               | 109,415         |             |                  |

\* Suspected error in the counts in section 14, see Appendix Table B-1.

alive on Sea Lion Rock at the time of marking was 6,380 (SE = 79.5) and total number of pups born was estimated to be 6,741.

The number of pups born and the number of harem bulls at different rookeries on St. Paul Island were significantly correlated ( $r^2 = 0.79$ , Fig. 7). The slope of the regression line with an estimated intercept was 17.25 (SE = 2.52), representing an estimate of the ratio of pups to breeding males. Excluding Vostochni, the regression slope was 27.54 (SE = 0.94,  $r^2 = 0.98$ , Fig. 7).

#### Number of Pups Born on St. George Island in 2008

Estimated total number of pups alive on St. George Island at the time of marking was 17,175 (SE = 261.5, Tables 7 and 8). The total number of dead pups was estimated to be 985 (Appendix Table B-7) and the estimated mortality rate was 5.4% (Table 8). The total number of pups born on St. George Island was 18,160 (SE = 288, 95% CI = (17,491 – 18,854)).

The 2008 estimate of pups born on St. George Island was significantly different than the estimate of pups born in 2006 ( $P < 0.01$ ) and was also significantly different than the estimate of pups born in 2004 ( $P < 0.01$ ). The number of pups born and the number of harem males on St. George Island rookeries were highly correlated ( $r^2 = 0.98$ ; Fig. 7). The intercept of the regression line was not significantly different from zero ( $P = 0.26$ ) and was not included in the regression equation.

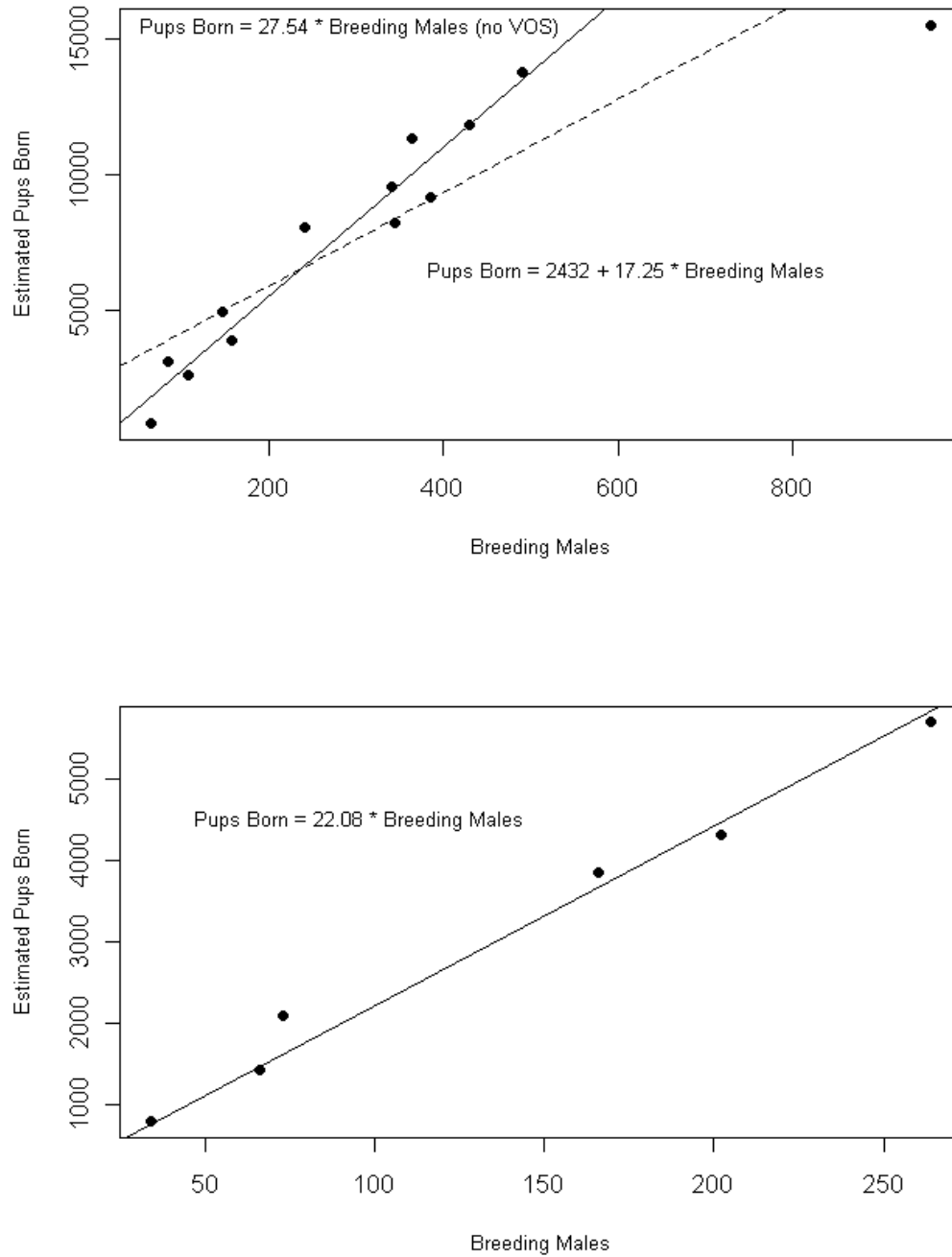


Figure 7.-- Pups born versus number of breeding males on St. Paul Island (top) and St. George Island (bottom), Alaska, 2008. Solid regression lines are shown for both locations; dotted line in top graph is regression including Vostochni (VOS) rookery at far right. See Appendix B-1 for the potential error in Vostochni harem male counts.

Table 7.-- Number of pups sheared, number of pups estimated to be alive at the time of marking (E1 and E2), mean number alive (Mean) and the standard error of the mean (SE), for St. George Island, Alaska, 2008.

| Rookery       | Sheared | E1    | E2    | Mean  | SE    |
|---------------|---------|-------|-------|-------|-------|
| South         | 403     | 3,613 | 3,680 | 3,647 | 33.5  |
| North         | 608     | 5,450 | 5,325 | 5,388 | 62.5  |
| East Reef     | 133     | 1,552 | 1,136 | 1,344 | 208.0 |
| East Cliffs   | 399     | 4,213 | 3,943 | 4,078 | 135.0 |
| Staraya Artil | 106     | 779   | 721   | 750   | 29.0  |
| Zapadni       | 243     | 2,000 | 1,936 | 1,968 | 32.0  |

Table 8.-- Number of pups alive at the time of marking, total pups born, harem males, and the ratio of pups alive at marking to harem males for St. George Island, Alaska, 2008.

| Rookery       | Pups alive<br>at marking | Total<br>pups born | Harem<br>males | Ratio<br>pups/males |
|---------------|--------------------------|--------------------|----------------|---------------------|
| South         | 3,647                    | 3,856              | 166            | 23.23               |
| North         | 5,388                    | 5,697              | 264            | 21.58               |
| East Reef     | 1,344                    | 1,421              | 66             | 21.53               |
| East Cliffs   | 4,078                    | 4,312              | 202            | 21.35               |
| Staraya Artil | 750                      | 793                | 34             | 23.32               |
| Zapadni       | 1,968                    | 2,081              | 73             | 28.51               |
| Total         | 17,175                   | 18,160             | 805            | 22.56               |

### Trends in Numbers of Pups

The total estimated number of pups born on St. Paul Island in 2008 (not including Sea Lion Rock) was 6.6% less than in 2006 (Fig. 8;  $P < 0.01$ ). On St. Paul Island, estimated numbers of fur seal pups born in 2006 were 10.5% less than in 2004 (Appendix Table B-4). On St. George Island there was a 1.2% increase between 2004 and 2006, and a 6.4% increase between 2006 and 2008. Since 2002, pup production has been below the estimated pup production seen in 1919 on St. Paul Island and below the estimated pup production seen in 1916 on St. George Island, when the population was recovering from a pelagic harvest that ended in the early 20<sup>th</sup> century; during these years pup production increased at about 8% per year.

Pup production on the Pribilof Islands has declined from 1998 to 2008 at an annual rate of 5.70% (SE = 0.38%,  $P < 0.01$ ) on St. Paul Island and 2.62% (SE = 0.75%,  $P = 0.02$ ) on St. George Island. The overall rate of decline on the Pribilof Islands (excluding Sea Lion Rock) was 5.22% (SE = 0.40%,  $P < 0.01$ ) from 1998 to 2008.

### Estimate of Total Stock Size

Rough estimates of the total fur seal abundance have been determined using a correction factor derived from estimates of survival and fecundity using data collected at sea during 1958 to 1974 (Loughlin et al. 1994). Its application here rests on the assumption that these vital rates were still valid. Since we cannot verify this assumption, the estimate must be viewed as a rough approximation. Total abundances were calculated by multiplying the average number of pups born over the past three censuses by a correction factor of 4.47 (See Table 9 for the calculation method). The estimate of the total stock for the Pribilof Islands population in 2008 (Table 9) was about 609,000 fur seals. The total stock size for the United States, which includes

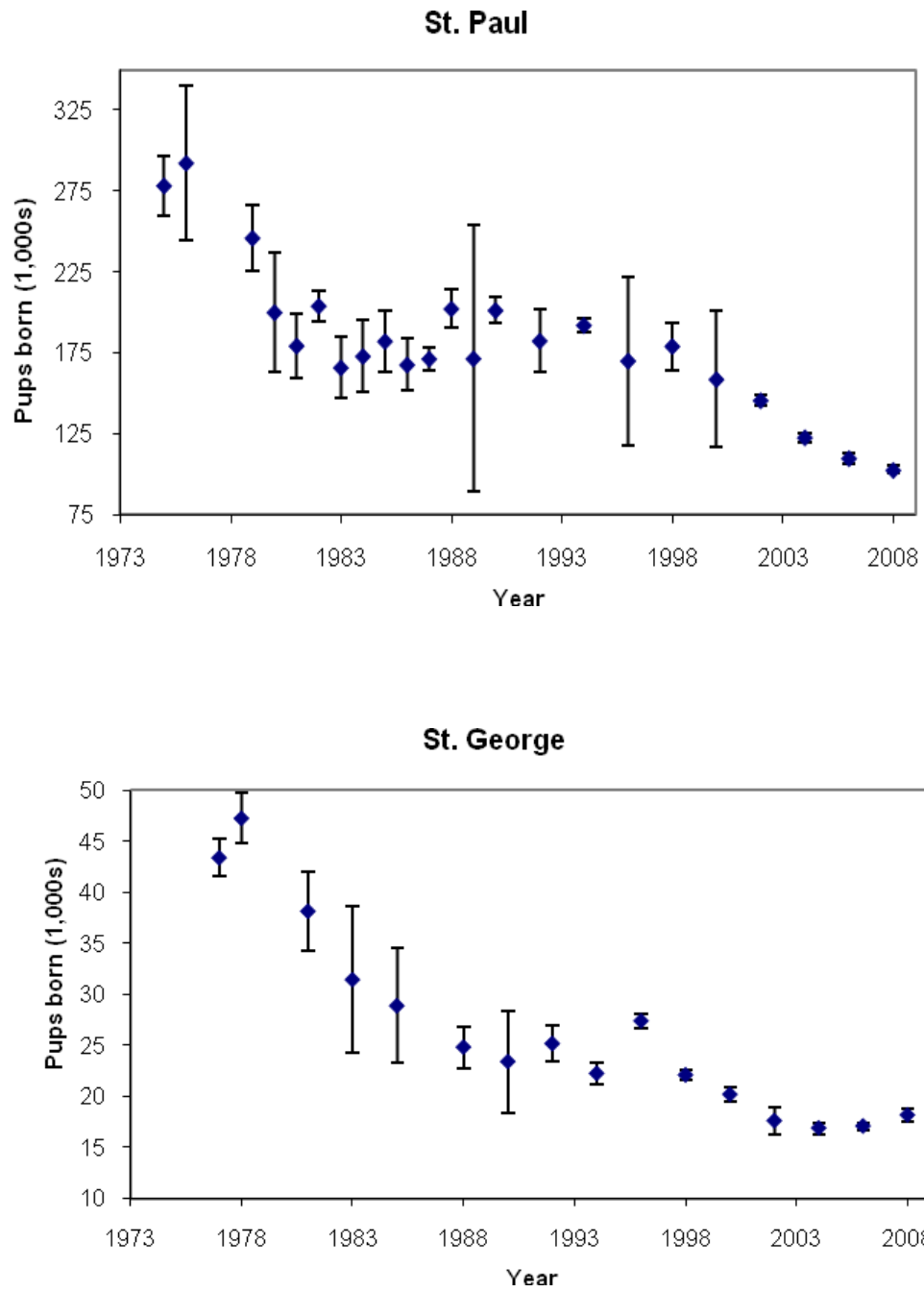


Figure 8.-- Estimated number of pups born ( $\pm$  95% confidence intervals) on St. Paul and St. George Islands, Alaska, 1975 to 2008.

Table 9.-- Details of the computation of stock size estimates of fur seals in U.S. rookeries in 2008. Separate columns are given for the Pribilof (St. George and St. Paul Islands, including Sea Lion Rock) and non-Pribilof populations (San Miguel and Bogoslof Islands).

| Formula                                   | Pribilof Islands | San Miguel and Bogoslof Islands <sup>2</sup> | Component          |
|---|------------------|--|--------------------|
| Average for 2004, 2006, 2008 <sup>1</sup> | 135,925          | 17,598                                       | Pups               |
| (Pups) × (0.5)                            | 67,962           | 8,799  | Yearlings          |
| (Yearlings) × (0.8)                       | 54,370           | 7,039  | Age 2 year         |
| (2-year-old females) × (0.86)/2           | 23,379           | 3,027  | Females age 3 year |
| (2-year-old males) × (0.8)/2              | 21,748           | 2,816  | Males age 3 year   |
| (Total pups) / (0.6)                      | 226,542          | 29,330                                       | Females 3+ years   |
| (3-year-old males) × (3.6)                | 78,293           | 10,138                                       | Males 4+ years     |
| Total                                     | 608,219          | 78,747                                       |                    |

<sup>1</sup> The 2008 estimate for Sea Lion Rock was added to the St. Paul estimates of pup production for all years because it is the most current.

<sup>2</sup> The 2006, 2007, and 2008 estimates for San Miguel Island and the 2005 and 2007 estimates for Bogoslof Island were used.

the Pribilof, Bogoslof (RR Ream, National Marine Mammal Laboratory, unpublished data), and San Miguel Islands (Melin et al. 2008), was approximately 687,000 fur seals.

#### Counts of Dead Fur Seals Older Than Pups and Collection of Teeth

A total of 57 dead adults were counted on rookeries sampled for dead pups and tooth samples were collected from a total of 52 fur seals: 41 on St. Paul Island and 11 on St. George Island (Table 10). Appendix Table B-8 summarizes the number of dead male and female fur seals from which teeth were collected from 1973 to 2008.



Table 10.-- Number of animals older than pups found dead and from which teeth were collected during August 2008 on the Pribilof Islands.

| Rookery              | Male | Female | Unknown | Total |
|----------------------|------|--------|---------|-------|
| <u>St. Paul</u>      |      |        |         |       |
| Gorbach <sup>1</sup> | 2    | 13     | 0       | 15    |
| Morjovi <sup>2</sup> | 0    | 9      | 0       | 9     |
| Polovina             | 0    | 1      | 0       | 1     |
| Tolstoi              | 2    | 18     | 0       | 20    |
| Total St. Paul       | 4    | 41     | 0       | 45    |
| <u>St. George</u>    |      |        |         |       |
| North                | 1    | 7      | 0       | 8     |
| East Reef            | 0    | 1      | 0       | 1     |
| Zapadni <sup>3</sup> | 1    | 2      | 0       | 3     |
| Total St. George     | 2    | 10     | 0       | 12    |
| Total Both Islands   | 6    | 51     | 0       | 57    |

<sup>1</sup> No teeth collected from two females.

<sup>2</sup> No teeth collected from two females.

<sup>3</sup> No teeth collected from one male.

MASS, LENGTH, AND SEX RATIOS OF NORTHERN FUR SEAL PUPS  
ON THE PRIBILOF ISLANDS, 2008

by

Rodney G. Towell, Rolf R. Ream, James R. Thomason, Katherine A. Call,  
Tonya K. Zeppelin, and Robert Caruso

Mass and length measurements of northern fur seal pups on St. Paul and St. George Islands have historically been recorded in late August and serve as an indicator of population health. Here we report average mass, average lengths, and sex ratios for male and female pups from Tolstoi, Vostochni, Polovina Cliffs, and Reef rookeries on St. Paul Island and all rookeries on St. George Island in 2008. We also report on comparisons of mass, length, and sex ratios between islands.

METHODS

Pups were sampled in mid- to late August using the techniques described by Antonelis (1992) and Robson et al. (1994). A Pesola spring scale was used to weigh pups to the nearest 0.2 kg; lengths were measured to the nearest centimeter. We limited statistical comparisons to an analysis of variance of pup mass and length by island, sex, and rookery variables. Significant differences in mass and length by sex between islands were compared using a two-sample t-test for samples with variances not significantly different from one another, or a Welch-modified two-sample t-test (Snedecor and Cochran, 1980) for samples with significantly different variances. We used an exact binomial test to determine if the proportion of female pups at different islands and rookeries was significantly different from 50%.

## RESULTS

### Pup Mass and Length

Pup mass (Fig. 9, Table 11) varied significantly by sex ( $P < 0.01$ ) on St. Paul Island in 2008. Mass of male and female pups was analyzed separately because the variance for males was greater than that for females ( $P < 0.01$ ) on St. Paul Island in 2008. Rookery effects on mass were significant for males ( $P = 0.02$ , Table 12) but not for females ( $P = 0.11$ , Table 12). The variance in pup lengths was not significantly different between males and females ( $P = 0.32$ ); therefore, the sexes were analyzed together. Pup lengths (Fig. 10, Table 13) were significantly different by sex on St. Paul Island ( $P < 0.01$ , Table 14).

On St. George Island, pup mass (Fig. 9, Table 15) was also significantly different by sex ( $P < 0.01$ ). Again, male and female pup masses were analyzed separately due to the difference in the variances for each sex. Rookery was a significant factor in the analysis of female mass ( $P < 0.01$ , Table 16) but not for male mass ( $P = 0.46$ ). The variance in pup lengths was not significantly different between males and females ( $P = 0.16$ ). The analysis of variance for lengths (Fig. 10, Tables 17 and 18) indicated significant differences by sex ( $P < 0.01$ ).

Mass and length were compared between islands by sex after testing for unequal variances with an F-statistic assuming normal distributions. There was significant difference between islands for male (St. Paul 8.97 kg, St. George 9.23 kg,  $P = 0.02$ ) and for female (St. Paul 7.64 kg, St. George 7.95 kg,  $P < 0.01$ ) mass. Males (St. Paul 75.4 cm, St. George 74.5 cm) were significantly longer on St. Paul Island ( $P < 0.01$ ) but there was no difference ( $P = 0.59$ ) between lengths of female pups (St. Paul 72.1 cm, St. George 72.0 cm).

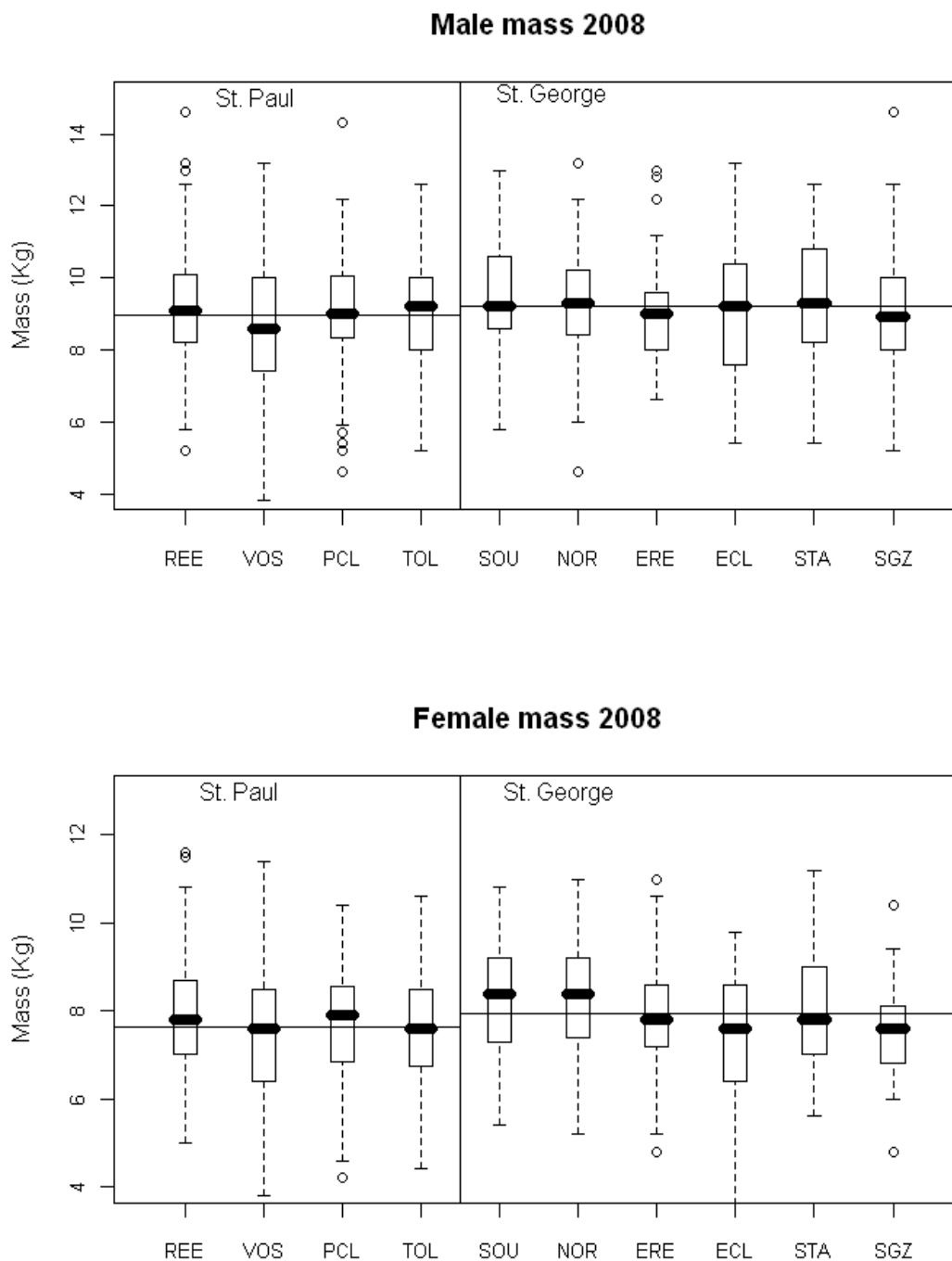


Figure 9.-- Boxplots of the mass of northern fur seal pups on St. Paul and St. George Islands, Alaska, August 2008: Reef (REE), Vostochni (VOS), Polovina Cliffs (PCL), Tolstoi (TOL), South (SOU), North (NOR), East Reef (ERE), East Cliffs (ECL), Staraya Artil (STA), and St. George Zapadni (SGZ). Whiskers represent 1.5X the interquartile range; open circles are outliers.

Table 11.-- Mean mass (kg), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups weighed on St. Paul Island, Alaska, 22-23 August 2008.

| Rookery     |    | Females | Males | Combined |
|-------------|----|---------|-------|----------|
| Reef        | kg | 7.83    | 9.19  | 8.53     |
| 23 August   | SD | 1.27    | 1.61  | 1.61     |
|             | n  | 124     | 133   | 257      |
| Vostochni   | kg | 7.54    | 8.64  | 8.07     |
| 22 August   | SD | 1.43    | 1.81  | 1.74     |
|             | n  | 141     | 156   | 297      |
| Pol. Cliffs | kg | 7.71    | 9.10  | 8.35     |
| 22 August   | SD | 1.23    | 1.51  | 1.53     |
|             | n  | 125     | 124   | 268      |
| Tolstoi     | kg | 7.55    | 9.02  | 8.37     |
| 23 August   | SD | 1.40    | 1.60  | 1.68     |
|             | n  | 91      | 115   | 206      |
| Combined    | kg | 7.64    | 8.97  | 8.32     |
|             | SD | 1.33    | 1.66  | 1.65     |
|             | n  | 500     | 528   | 1,028    |

Table 12.-- Analyses of variance of mass of male and female northern fur seal pups across rookeries on St. Paul Island, Alaska, August 2008.

| Factor  | df | SS due<br>to factor | MSS* | Residual | df  | F    | P    |
|---------|----|---------------------|------|----------|-----|------|------|
| Females |    |                     |      |          |     |      |      |
| Rookery | 3  | 10.75               | 3.58 | 877      | 496 | 2.03 | 0.11 |
| Males   |    |                     |      |          |     |      |      |
| Rookery | 3  | 25.8                | 8.6  | 1,424    | 524 | 3.16 | 0.02 |

\*MSS = SS divided by df

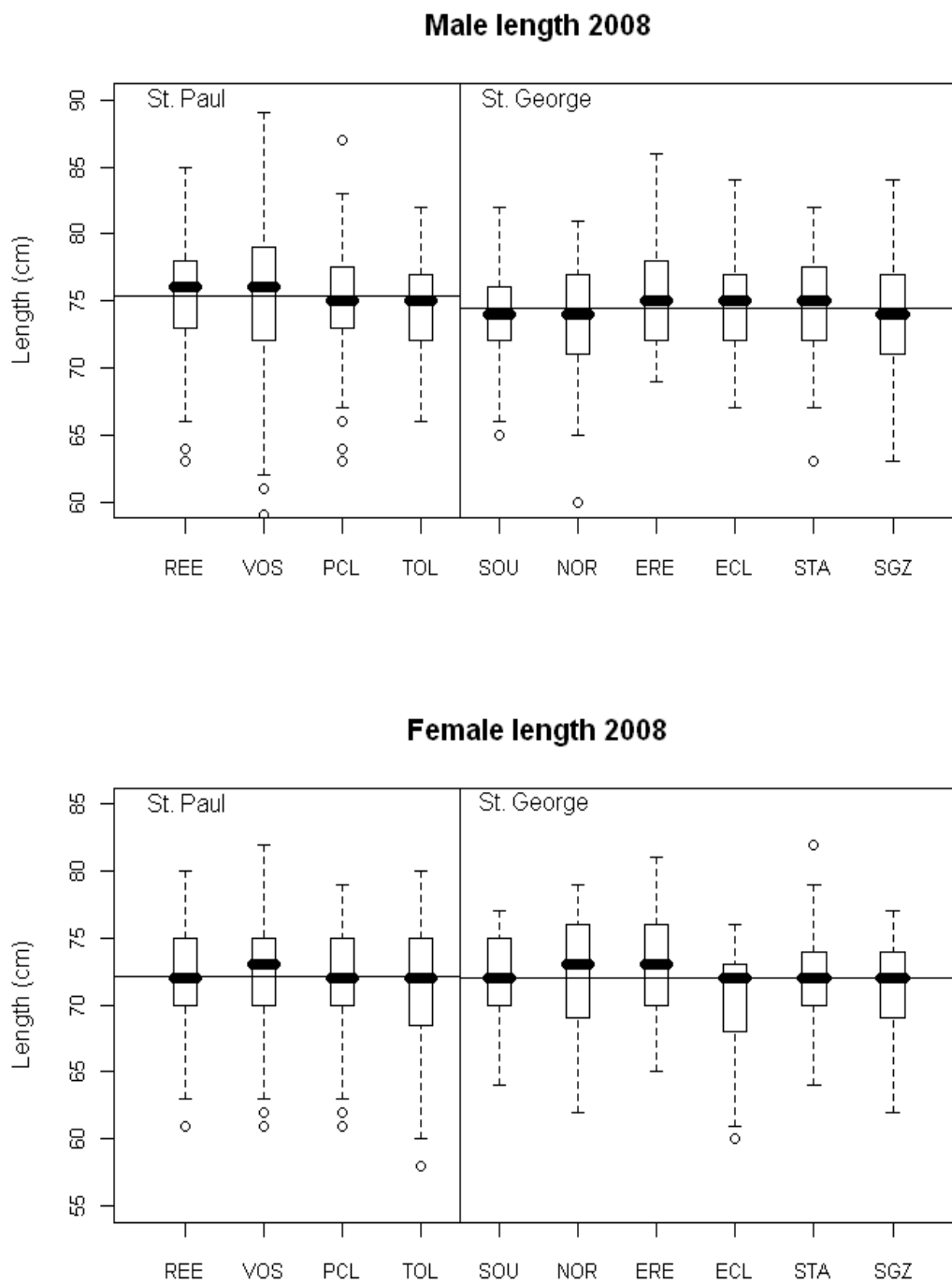


Figure 10.-- Boxplots of the length of northern fur seals on St. Paul and St. George Islands, Alaska, August 2008: Reef (REE), Vostochni (VOS), Polovina Cliffs (PCL), Tolstoi (TOL), South (SOU), North (NOR), East Reef (ERE), East Cliffs (ECL), Staraya Artil (STA), and St. George Zapadni (SGZ). Whiskers represent 1.5X the interquartile range; open circles are outliers.

Table 13.-- Mean length (cm), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups measured on St. Paul Island, Alaska, 22-23 August 2008.

| Rookery     |    | Females | Males | Combined |
|-------------|----|---------|-------|----------|
| Reef        | cm | 72.2    | 75.7  | 74.0     |
| 23 August   | SD | 3.6     | 4.1   | 4.2      |
|             | n  | 124     | 133   | 257      |
| Vostochni   | cm | 72.6    | 75.5  | 74.2     |
| 22 August   | SD | 4.4     | 5.0   | 5.0      |
|             | n  | 141     | 156   | 297      |
| Pol. Cliffs | cm | 71.8    | 75.2  | 73.4     |
| 22 August   | SD | 3.9     | 4.1   | 4.3      |
|             | N  | 144     | 124   | 268      |
| Tolstoi     | cm | 71.6    | 74.9  | 73.5     |
| 23 August   | SD | 4.6     | 3.6   | 4.4      |
|             | n  | 91      | 116   | 207      |
| Combined    | cm | 72.1    | 75.4  | 73.8     |
|             | SD | 4.1     | 4.3   | 4.5      |
|             | n  | 500     | 529   | 1,029    |



Table 14.-- Analyses of variance of length of male and female northern fur seal pups on St. Paul Island, Alaska, August 2008.

| Factor  | df | SS due<br>to factor | MSS*  | Residual | df    | F      | P      |
|---------|----|---------------------|-------|----------|-------|--------|--------|
| Sex     | 1  | 2,738               | 2,738 | 18,151   | 1,027 | 155.35 | < 0.01 |
| Rookery | 3  | 105                 | 35    | 18,046   | 1,024 | 1.98   | = 0.11 |

\*MSS = Sum of squares (SS) divided by df.

Table 15.-- Mean mass (kg), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups weighed on St. George Island, Alaska, 22-24 August 2008.

| Rookery       |    | Females | Males | Combined |
|---------------|----|---------|-------|----------|
| South         | kg | 8.31    | 9.53  | 8.98     |
| 23 August     | SD | 1.25    | 1.60  | 1.57     |
|               | n  | 47      | 57    | 104      |
| North         | kg | 8.34    | 9.21  | 8.77     |
| 24 August     | SD | 1.39    | 1.60  | 1.55     |
|               | n  | 54      | 54    | 108      |
| East Reef     | kg | 7.94    | 9.04  | 8.40     |
| 22 August     | SD | 1.35    | 1.52  | 1.52     |
|               | n  | 58      | 42    | 100      |
| East Cliffs   | kg | 7.51    | 9.15  | 8.40     |
| 22 August     | SD | 1.44    | 1.83  | 1.84     |
|               | n  | 46      | 54    | 100      |
| Staraya Artil | kg | 7.89    | 9.40  | 8.74     |
| 24 August     | SD | 1.37    | 1.61  | 1.68     |
|               | n  | 50      | 64    | 114      |
| Zapadni       | kg | 7.59    | 8.98  | 8.39     |
| 23 August     | SD | 1.12    | 1.70  | 1.63     |
|               | n  | 43      | 58    | 101      |
| Combined      | kg | 7.95    | 9.23  | 8.62     |
|               | SD | 1.35    | 1.65  | 1.65     |
|               | n  | 298     | 329   | 627      |

Table 16.-- Analyses of variance of mass of male and female northern fur seal pups across rookeries on St. George Island, Alaska, August 2008.

| Factor  | df | SS due to factor | MSS* | Residual | df  | F    | P      |
|---------|----|------------------|------|----------|-----|------|--------|
| Females |    |                  |      |          |     |      |        |
| Rookery | 5  | 28.8             | 5.8  | 516      | 292 | 3.27 | < 0.01 |
| Males   |    |                  |      |          |     |      |        |
| Rookery | 5  | 12.7             | 2.5  | 879      | 323 | 0.93 | 0.46   |

\*MSS = Sum of squares (SS) divided by df.

Table 17.-- Mean length (cm), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups measured on St. George Island, Alaska, 22-24 August 2008.

| Rookery       |    | Females | Males | Combined |
|---------------|----|---------|-------|----------|
| South         | cm | 72.0    | 74.2  | 73.2     |
| 23 August     | SD | 3.2     | 3.8   | 3.7      |
|               | n  | 47      | 57    | 104      |
| North         | cm | 72.5    | 74.0  | 73.2     |
| 24 August     | SD | 4.1     | 4.4   | 4.3      |
|               | n  | 54      | 54    | 108      |
| East Reef     | cm | 73.1    | 75.1  | 74.0     |
| 22 August     | SD | 3.8     | 4.1   | 4.1      |
|               | n  | 58      | 42    | 100      |
| East Cliffs   | cm | 70.4    | 74.8  | 72.8     |
| 22 August     | SD | 4.0     | 4.3   | 4.7      |
|               | n  | 46      | 54    | 100      |
| Staraya Artil | cm | 71.9    | 74.8  | 73.5     |
| 24 August     | SD | 3.6     | 4.0   | 4.1      |
|               | n  | 50      | 64    | 114      |
| Zapadni       | cm | 71.2    | 74.2  | 72.9     |
| 23 August     | SD | 3.7     | 4.3   | 4.3      |
|               | n  | 43      | 58    | 101      |
| Combined      | cm | 72.0    | 74.5  | 73.3     |
|               | SD | 3.8     | 4.1   | 4.2      |
|               | n  | 298     | 329   | 627      |

Table 18.-- Analyses of variance of length of male and female northern fur seal pups across rookeries on St. George Island, Alaska, August 2008.

| Factor  | df | SS due<br>to factor | MSS*  | Residual | df  | F     | P     |
|---------|----|---------------------|-------|----------|-----|-------|-------|
| Sex     | 1  | 1,025               | 1,025 | 9,937    | 625 | 64.93 | <0.01 |
| Rookery | 5  | 154                 | 31    | 9,783    | 620 | 1.96  | 0.08  |

\*MSS = Sum of square (SS) divided by df.

### Sex Ratios

The proportions of female pups were not significantly different from 50% on any of the sample rookeries on St. Paul or St. George Islands in 2008 (Table 19). Also, the proportion of female pups was not significantly different than 50% (48.6%,  $P = 0.38\%$ ) on St. Paul Island, St. George Island (47.5%,  $P = 0.23$ ), or for both islands combined (48.2%,  $P = 0.15$ ).

### DISCUSSION

Consistent with earlier evaluations of pup mass data (York and Antonelis 1990, York and Towell 1993, Towell et al. 1996, and Towell et al. 1997), the strongest pattern was that the size of pups varied by sex: male pups were heavier and longer than female pups. After controlling for sex, both male and female pups were significantly heavier on St. George Island, while male pups on St. Paul Island were significantly longer than those on St. George Island. The proportion of pups that was female was not significantly different than 50% on St. Paul Island (48.6%, Table 20), or on St. George Island (47.5%) in 2008, though across the past two decades the only significant differences from a 50:50 sex ratio have favored males (Table 20). These differences in mass and length may reflect the influence of environmental variability on the condition of pups and their mothers. Undetected biases in sampling techniques may also be responsible for the differences detected in this study. The protocol for taking length measurements is subjective and the process should be more closely examined.

Table 19. -- Numbers of female pups, total number of pups, and proportion (that are female) of northern fur seal pups sampled during pup weighing on St. Paul and St. George Islands, Alaska, August 2008. The fraction of females was not significantly less than 50% ( $P = 0.05$ ) for any of the rookeries or islands.

| Rookery           | Females | Total | Fraction |
|-------------------|---------|-------|----------|
| <u>St. Paul</u>   |         |       |          |
| Reef              | 124     | 257   | 0.482    |
| Vostochni         | 141     | 297   | 0.475    |
| Polovina Cliffs   | 144     | 268   | 0.537    |
| Tolstoi           | 91      | 207   | 0.440    |
| Total             | 500     | 1,029 | 0.486    |
| <u>St. George</u> |         |       |          |
| South             | 47      | 104   | 0.452    |
| North             | 54      | 108   | 0.500    |
| East Reef         | 58      | 100   | 0.580    |
| East Cliffs       | 46      | 100   | 0.460    |
| Staraya Artil     | 50      | 114   | 0.439    |
| Zapadni           | 43      | 101   | 0.426    |
| Total             | 298     | 627   | 0.475    |

Table 20.-- Numbers of female pups, total number of pups, and proportion (that are female) of live northern fur seals pups captured during weighing operations on St. Paul and St. George Islands, Alaska, for the years 1992-2008. Bold numbers indicate the proportion of females significantly different than 50%.

| Year | St. Paul   |              |              | St. George |            |              |
|------|------------|--------------|--------------|------------|------------|--------------|
|      | Females    | Total        | Fraction     | Females    | Total      | Fraction     |
| 1992 | <b>494</b> | <b>1118</b>  | <b>0.442</b> | <b>291</b> | <b>634</b> | <b>0.459</b> |
| 1994 | 926        | 1926         | 0.481        | 430        | 886        | 0.485        |
| 1995 | <b>939</b> | <b>2040</b>  | <b>0.460</b> | <b>294</b> | <b>653</b> | <b>0.450</b> |
| 1996 | <b>520</b> | <b>1149</b>  | <b>0.453</b> | <b>331</b> | <b>749</b> | <b>0.442</b> |
| 1997 | 495        | 1020         | 0.485        | 311        | 639        | 0.487        |
| 1998 | <b>506</b> | <b>1100</b>  | <b>0.460</b> | <b>344</b> | <b>745</b> | <b>0.462</b> |
| 1999 | <b>462</b> | <b>1081</b>  | <b>0.427</b> | --         | --         | --           |
| 2000 | 543        | 1079         | 0.503        | <b>292</b> | <b>640</b> | <b>0.456</b> |
| 2001 | <b>510</b> | <b>1095</b>  | <b>0.466</b> | --         | --         | --           |
| 2002 | <b>424</b> | <b>1016</b>  | <b>0.417</b> | 300        | 627        | 0.478        |
| 2004 | <b>489</b> | <b>1,067</b> | <b>0.458</b> | <b>279</b> | <b>619</b> | <b>0.451</b> |
| 2006 | <b>446</b> | <b>983</b>   | <b>0.454</b> | 304        | 640        | 0.475        |
| 2008 | 500        | 1,029        | 0.486        | 298        | 627        | 0.475        |



STATUS OF THE NORTHERN FUR SEAL POPULATION  
AT SAN MIGUEL ISLAND, CALIFORNIA, 2008-2009

by

Anthony J. Orr, Sharon R. Melin, and Robert L. DeLong

Demographic studies of the northern fur seal population at San Miguel Island (SMI), California, have been conducted since discovery of the colony in 1968. The population was established by individuals from the Pribilof, Commander, Kurile, and Robben Islands during the late 1950s or early 1960s (DeLong 1982). Northern fur seals in U.S. waters primarily inhabit cool, subarctic waters in the high latitudes of the North Pacific Ocean and Bering Sea. They are able to inhabit SMI because the marine environment around the island is influenced by the California Current and coastal upwelling, which produces cold surface waters, fog, and wind conditions that keep the island cool during summer months when northern fur seals return to pup and breed (DeLong 1982).

The northern fur seal population has thrived at SMI except for two severe declines during 1983 and 1998 that were associated with El Niño events (DeLong and Antonelis 1991, Melin and DeLong 2000). El Niño events cause changes in marine communities by altering the sea-level height, sea-surface temperature, thermocline and nutricline depths, current-flow patterns, and upwelling strength of marine ecosystems (Norton et al. 1985, Arntz et al. 1991). These environmental changes result in decreased productivity at lower trophic levels that adversely affect abundance and availability of species at higher trophic levels. Prey of fur seals generally move farther north and deeper in the water column (Arntz et al. 1991) and thereby become less accessible for fur seals. Consequently, fur seals at SMI are in poor physical condition during

El Niño events and the population experiences reduced reproductive success and high mortality of pups, and occasionally adults (DeLong and Antonelis 1991, Melin and DeLong 1994, Melin et al. 1996, Melin and DeLong 2000). Because El Niño events occur periodically along the California coast and impact the population growth of fur seals at SMI, they play an influential role in the dynamics of this population (DeLong and Antonelis 1991, Melin and DeLong 1994, Melin et al. 1996).

El Niño events are short-term events that affect a population on the order of one to two years. But long-term oceanographic processes, such as the Pacific Decadal Oscillation (PDO), also occur and result in large-scale and basin-wide changes in ecosystems (Hayward et al. 1999). The PDO is primarily based upon patterns of variation in sea-surface temperatures in the Pacific Ocean and is often referred to being in one of two phases, “warm” or “cool”, depending on the sign of sea-surface temperature anomalies. Each phase can persist for decades, affecting several generations of fur seals. The California Current System (CCS) shifted into a “warm” phase in 1977, and in 1998 it transitioned into a “cool” phase (Hayward et al. 1999). Recently, the decadal cycles have broken down and the PDO has switched from a “cool” phase (1998-2002), followed by a “warm” phase (2002-2005), followed by a neutral phase (2005-August 2007), to a “cool” phase (September 2007-July 2009; McClatchie et al. 2008, NWFSC 2009). Since August 2009, the PDO has been classified as being in a “warm” phase, perhaps due to the El Niño event developing at the equator during fall and winter 2009-2010 (NWFSC 2009).

In general, productivity near SMI should increase and cooler environmental conditions should prevail during a “cool” phase of the PDO. During the last 11 years following the 1998 El Niño, 8 years have been dominated by “cool” or “neutral” PDO conditions that should have resulted in higher productivity, survival, and good condition of northern fur seal pups at SMI.

However, hookworm disease, which has plagued the population for the past 13 years, and a mild El Niño event in 2002 mitigated the positive effects of the “neutral to cool” PDO. Within the PDO cycle, local and regional processes can have a significant impact on biological productivity within the system, likely affecting the dynamics of the northern fur seal population at SMI. An example of such processes occurred during 2009 when an anomalous warm oceanographic event transpired in the CCS along the south and central California coast. Strong positive upwelling conditions existed during February through April, however a transition to negative upwelling started in May and intensified in June, during which the strongest negative upwelling event occurred in the past 40 years for the southern and central California coast. Positive upwelling conditions returned by September. This event occurred during the reproductive season of northern fur seals and California sea lions (CSLs; *Zalophus californianus*) at SMI and had dramatic effects on the CSL population (Melin et al. 2010). Here, we present the results of the 2008 and 2009 northern fur seal population monitoring studies at SMI and discuss the importance of disease and environmental influences on the population trends during the past 13 years (1997-2009).

## METHODS

### Census

Fur seal censuses were conducted at two rookeries of SMI (34°01' N, 120°26' W): Adams Cove on the main island and Castle Rock, located ~1 km northwest of SMI. The Castle Rock rookery was visited only once each July, to conduct a census of live pups. Daily censuses were conducted at the Adams Cove rookery between 27 May and 20 July 2008, and 20 May and 23 July 2009. Territorial bull counts were used as an index of the maximum number of breeding

bulls and the cumulative live pup count was used to determine the date of the first birth and median pupping date for each year. In 2001 and 2007, daily censuses were terminated too early in the season to determine a median pupping date.

Counts of live and dead pups were used as an index of the number of pups born at the Castle Rock and Adams Cove rookeries. Total births each year was the sum of the number of live pups counted at the census and the cumulative number of dead pups counted up to the time of the live pup census. Live pup censuses were conducted during late July. Dates of the censuses were determined by the frequency of births observed during daily surveys in the Adams Cove rookery. When no births were documented over three consecutive days, pupping was considered complete and the live pup census was conducted. In Adams Cove, the live pup census was conducted on 30 July 2008 and 31 July 2009. The live pup census was conducted on 30 July 2008 and 19 August 2009 at Castle Rock. In Adams Cove, the live pup counts were conducted from a mobile blind by two observers using binoculars. At Castle Rock, pups were counted by two observers moving through the colony. The observers defined section boundaries while counting in each area to ensure that they were counting the same groups of animals. Counts were not compared until the end of the day to ensure independence between observer counts. At Adams Cove, the substrate is sandy and there are no markers to delineate counting areas. Pups are often moving between territories or are located outside a territory boundary and large errors in counts can often be attributed to differences in the areas that the observers counted. The number of pups for the colony was estimated from the mean of both observers' counts.

In Adams Cove, fur seal pup mortality surveys were conducted between July and September 2008 and between June and October 2009. Each dead pup was counted, removed

from the territory, and then stacked away from the survey area to minimize the possibility of recounting the same pup during the season. Because pups died and disappeared between surveys, the observed count was an underestimate of the total mortality. In a departure from the methods in previous reports, we estimated total mortality by calculating a correction factor for the observed mortality in Adams Cove based on a daily disappearance rate of dead CSL pups in the same area that were tagged and resighted during subsequent trips to the island (1.33 for early season mortality and 1.25 for late season mortality). Thus, the total births and pup mortality in Table 22 will not agree with those in previous reports (Melin and DeLong 2001, Melin et al. 2002, Melin et al. 2005). We have not estimated a species-specific mortality correction factor for northern fur seal pups at SMI because we do not have access to the territories early in the season due to breeding CSLs. The processes contributing to disappearance of dead pups (e.g. surf, sand, flooding) for the two species are similar except that a greater proportion of dead northern fur seal pups are more likely to be washed out to sea relative to CSLs because CSL territories are located along the beach crest. However, we believe the correction factor is a suitable (although minimal) approximation of the disappearance rate of dead northern fur seal pups.

At Castle Rock, pup mortality was estimated from one survey conducted at the time of the live pup count during 2009 (19 August); no mortality survey was conducted in 2008. Pup mortality at Castle Rock in 2009 was a minimum estimate because only one survey was performed and the number of carcasses that decomposed or disappeared were not determined.

#### Tagging and Pup Condition

Since 1975, between 100 and 300 northern fur seal pups have been flipper-tagged annually when 2-3 months old in Adams Cove. Pups were tagged on each foreflipper, weighed,

sexed, measured (length), and released. We used pup weight at the time of tagging as an index of pup condition. To account for differences in mean pup weights due to different weighing dates among years, we developed a predictive linear mixed-effects model with normal errors that was used to adjust the observed mean weight to 1 October for each year (between 1975 and 2009) using an estimated sex-specific daily growth rate and a random cohort effect for the daily growth rate to incorporate annual variation in growth rate.

#### Sightings of marked individuals

Surveys of tagged breeding animals were conducted from a mobile blind in Adams Cove during 2008 (4 July – 2 August; n = 8) and 2009 (2 June – 22 August; n = 20). The blind was moved through sections of the rookery at least once a week and tag numbers and reproductive status were recorded for each tagged individual observed.

## RESULTS

#### Census

The maximum number of territorial bulls counted in Adams Cove was 154 during 2008 and 116 during 2009, representing a 24.7% decrease between the two years (Table 21). The maximum number of territorial bulls fluctuated from 1997 – 2009, with annual increases ranging from 2.2% to 32.8%, and declines between 1.7% and 45.5% (Table 21). The decline between 1997 and 1998 was the greatest (45.5%) observed; the highest increase occurred between 2001 and 2002 (32.8%). Even with increases in five years since 1997, the maximum number of territorial bulls in 2008 and 2009 were 39.1% and 54.2%, respectively, below the number observed in 1997, when the population was at its highest recorded level (Table 21).

The first live pup at Adams Cove was observed on 11 June in 2008 and 7 June in 2009, similar to previous years (1997 to 2007: n = 11, mean = 10 June, SD = 3.3 days). The median pupping

date was 9 July during both 2008 and 2009. The mean median pupping date between 1998 and 2009 was 7 July (SD = 2.7 days; not including 2001 and 2007). The total number of births at Adams Cove was 1838 during 2008 and 2133 during 2009. In 2008, the mean number of live pups counted at Castle Rock was 1076 (pup mortality was not estimated; Table 22); in 2009, the mean number was 984 (Table 22).

Total number of births at Adams Cove and Castle Rock remained lower from the historical highs recorded in 1997. At Adams Cove, total births were below 1997-levels during both 2008 (16.9%) and 2009 (3.6%; Table 22). At Castle Rock, total births in 2009 were 2.4% below 1997-levels. Total number of births was not determined at Castle Rock during 2008.

Early pup mortality (birth to 1 month old) has fluctuated over the past 13 years ranging from 5.8% (in 2001) to 43.1% (in 2007; Table 22). Total mortality (birth to 3 months old) ranged between 5.8% (in 2001) and 81.5% (in 2009; Table 22). At Adams Cove, total pup mortality rate was 37.6% during 2008 and 81.5% during 2009 (Table 22).

#### Tagging and Pup Condition

We tagged and weighed 3-month-old pups in 2008 (n = 199) and 2009 (n = 200) in Adams Cove to continue survival and condition studies. During 2008, estimated mean ( $\pm$ standard error) weights of female (7.2 kg  $\pm$  0.15) and male (8.6 kg  $\pm$  0.18) pups were lower than the long-term average for both sexes and were similar to weights observed during El Niño conditions at SMI (Fig. 11). In 2009, the estimated mean weights (9.9 kg  $\pm$  0.20 females; 10.5 kg  $\pm$  0.18 males) were higher than in 2008, but were still lower than the long-term average (Fig. 11).

Table 21. -- Maximum number of territorial northern fur seal bulls at Adams Cove on San Miguel Island, California, 1997-2009.

| Year | Maximum number of territorial bulls | Annual percent change in maximum number of territorial bulls | Percent change from maximum number of territorial bulls in 1997 |
|------|-------------------------------------|--|---|
| 1997 | 253                                 |  |   |
| 1998 | 138                                 | -45.5  | -45.5   |
| 1999 | 141                                 | 2.2  | -44.3   |
| 2000 | 108                                 | -23.4  | -57.3   |
| 2001 | 119                                 | 10.2   | -53.0   |
| 2002 | 158                                 | 32.8   | -37.5   |
| 2003 | 184                                 | 16.5   | -27.3   |
| 2004 | 127                                 | -31.0  | -49.8   |
| 2005 | 117                                 | -7.9   | -53.8   |
| 2006 | 115                                 | -1.7   | -54.6   |
| 2007 | 147                                 | 27.8   | -41.9   |
| 2008 | 154                                 | 4.7  | -39.1   |
| 2009 | 116                                 | -24.7  | -54.2   |



Table 22.-- Summary of pup counts of northern fur seals at Adams Cove and Castle Rock (rookeries of San Miguel Island) during

1997-2009. A dash (-) preceding the percent change indicates a decline.

| Colony/Year | Mean<br>number of<br>live pups<br>(SE) | Early<br>season<br>pup<br>mortality <sup>1</sup> | Total<br>births | Annual<br>percent<br>change in<br>total births | Percent<br>change         |  |  | Total pup<br>mortality<br>(rate <sup>3</sup> %) |
|-------------|--|--|-----------------|--|---------------------------|--|--|---|
|             |  |  |                 |  | from<br>births<br>in 1997 | Early<br>season pup<br>mortality<br>rate | Late season<br>pup<br>mortality <sup>2</sup> |   |
| Adams Cove  |  |  |                 |  |                           |  |  |   |
| 1997        | 1765 (8.5)                             | 448  | 2213            |  |                           |  | 717  | 1165 (52.6)                                     |
| 1998        | 308 (2.1)                              | 154  | 462             | -79.1  | -79.1                     |  | 142  | 296 (64.1)                                      |
| 1999        | 604 (3.4)                              | 225  | 829             | 79.4   | -62.5                     |  | 32   | 257 (31.0)                                      |
| 2000        | 962 (5.7)                              | 145  | 1107            | 33.5   | -50.0                     |  | 41   | 186 (16.8)                                      |
| 2001        | 1226 (2.1)                             | 76   | 1302            | 17.6   | -41.2                     |  | 0  | 76 (5.8)  |
| 2002        | 1126 (3.5)                             | 102  | 1228            | -5.7   | -44.5                     |  | 109  | 211 (17.2)                                      |
| 2003        | 1083 (2.8)                             | 302  | 1385            | 12.8   | -37.4                     |  | 82   | 384 (27.7)                                      |
| 2004        | 810 (3.5)                              | 606  | 1416            | 2.2  | -36.0                     |  | 219  | 825 (58.3)                                      |
| 2005        | 1133 (14.1)                            | 504  | 1637            | 15.6   | -26.0                     |  | 521  | 1025 (62.6)                                     |
| 2006        | 1129 (36.8)                            | 606  | 1735            | 6.0  | -21.6                     |  | 244  | 850 (49.0)                                      |
| 2007        | 972 (4.2)                              | 735  | 1707            | -1.6   | -22.9                     |  | 368  | 1103 (64.6)                                     |
| 2008        | 1390 (1.5)                             | 448  | 1838            | 7.7  | -16.9                     |  | 243  | 692 (37.6)                                      |
| 2009        | 1266 (19.0)                            | 867  | 2133            | 16.1   | -3.6                      |  | 871  | 1738 (81.5)                                     |

Table 22.--Continued.

| Colony/Year | Mean number of live pups | Early season pup mortality <sup>1</sup> | Total births | Annual percent change in total births | Percent change from births in 1997 |                            |  | Total pup mortality |
|-------------|--------------------------|---|--------------|---------------------------------------|------------------------------------|----------------------------|--|---------------------|
|             |                          |   |              |                                       | Early season pup mortality rate    | Early season pup mortality | Late season pup mortality <sup>2</sup> |                     |
| Castle Rock |                          |   |              |                                       |                                    |                            |  |                     |
| 1997        | 940 (5.4)                | 68                                      | 1008         |                                       |                                    |                            |  |                     |
| 1998        | 194 (1.2)                | 39                                      | 233          | -76.9                                 |                                    |                            |  |                     |
| 1999        | 300 (1.8)                | 15                                      | 315          | 35.2                                  | -76.9                              |                            |  |                     |
| 2000        | 562 (4.2)                | 17                                      | 579          | 83.8                                  | -68.8                              |                            |  |                     |
| 2001        | 708 (4.5)                | 57                                      | 765          | 32.1                                  | -42.6                              |                            |  |                     |
| 2002        | 724 (2.0)                | 28                                      | 752          | -1.7                                  | -24.1                              |                            |  |                     |
| 2003        | ---                      | ---                                     | ---          | ---                                   | -25.4                              |                            |  |                     |
| 2004        | 804 (4.2)                | 28                                      | 832          | 10.6                                  | ---                                |                            |  |                     |
| 2005        | 782 (3.5)                | 24                                      | 806          | -3.1                                  | -17.5                              |                            |  |                     |
| 2006        | 634 (36.8)               | 21                                      | 655          | -18.7                                 | -20.0                              |                            |  |                     |
| 2007        | 758 (9.1)                | ---                                     | 758          | 15.7                                  | -35.0                              |                            |  |                     |
| 2008        | 1076 (58)                | ---                                     | ---          | ---                                   | -24.8                              |                            |  |                     |
| 2009        | 800 (5.0)                | 184                                     | 984          | 29.8                                  | ---                                |                            |  |                     |
|             |                          |   |              |                                       | -2.4                               |                            |  |                     |
|             |                          |   |              |                                       | 18.7                               |                            |  |                     |

<sup>1</sup>Estimated number of dead pups at the time of the live pup census based on a correction factor of 1.33 to account for pups that are missed during surveys or disappear between surveys.

<sup>2</sup>Estimated number of dead pups after the live pup census based on a correction factor of 1.25 to account for pups that are missed during surveys or disappear between surveys.

<sup>3</sup>Rate calculated based on estimated total number of dead pups in early and late season surveys as percentage of live births.

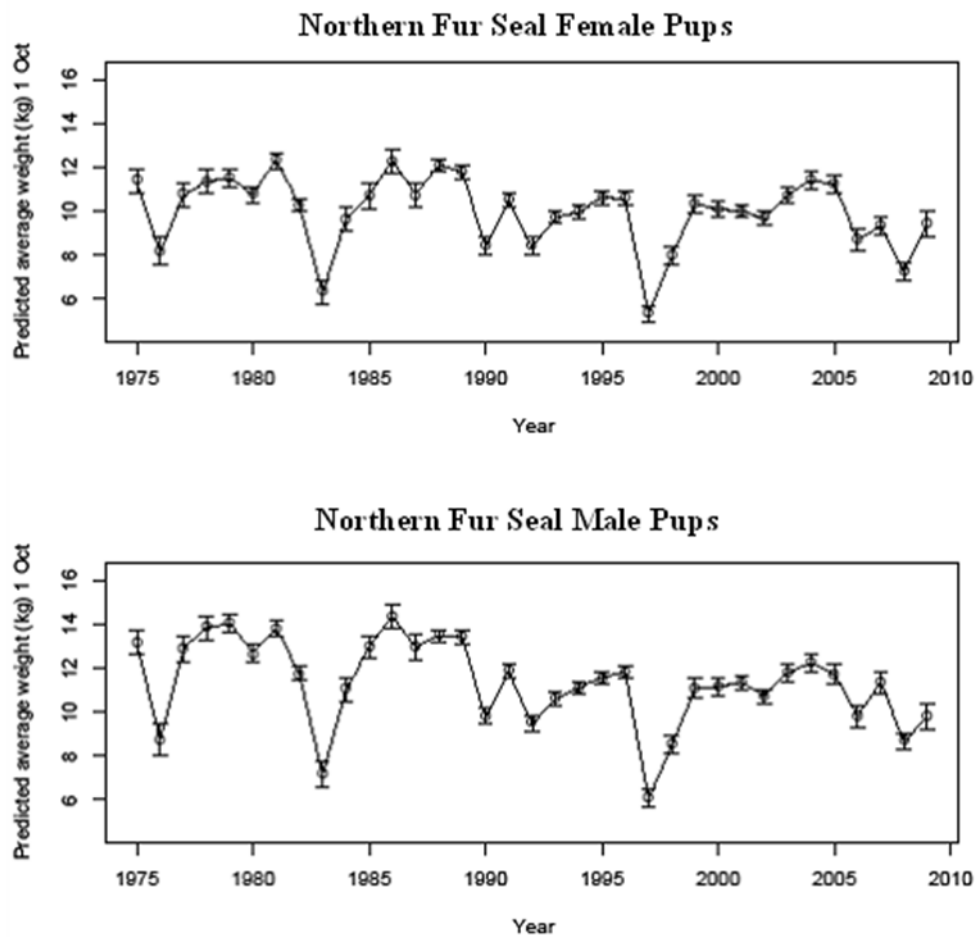


Figure 11.--Mean weights (kg) of northern fur seal pups at San Miguel Island, California, adjusted for a weighing date of 1 October each year. The weights are adjusted because pups were weighed on different dates throughout the time series. The correction factor is based on growth rates calculated for years when pups were weighed during September and October.

### Sightings of marked individuals

Adults tagged as pups were resighted during 2008 (females = 150, males = 144) and 2009 (females = 142, males = 92) in Adams Cove (Figs. 12a and 13b). Females ranged in age from 3 to 21 years old during 2008, and from 3 to 16 years old during 2009 (Fig. 12a). Females sighted with pups (54 in 2008, 38 in 2009) ranged between 4 and 21 years old (Fig. 12b). Five and seven-year-olds (18.5%) in 2008 and 8-year-olds (21.1%) in 2009 were the ages of females observed with the highest number of pups (Fig. 12b). Males ranged in age from 3 to 13 years old during 2008, and from 3 to 11 years old during 2009 (Fig. 13a). Territorial males (44 in 2008, 30 in 2009) were between 7 and 13 years old (Fig 13b). Eight-year old males had the highest number of territories during both 2008 and 2009 (Fig. 13b). Only a small proportion of females (17% in 2008, 8% in 2009) and even fewer males (2% in 2008, 0% in 2009) older than 12 years were recorded. There were no tagged individuals from the 1992 (16 years old in 2008, 17 years old in 2009) or 1997 (11 years old in 2008, 12 years old in 2009) cohorts seen during 2008 or 2009 (Figs. 12 and 13), perhaps indicating near total mortality of these cohorts due to El Niño conditions during those years.

### DISCUSSION

The CCS has experienced two “cold” phases of the PDO during the past decade (1998-2002 and 2007-July 2009), which was predicted to create advantageous ocean conditions for northern fur seals at SMI and should have resulted in good condition, high productivity and survival of animals. However, the number of territorial bulls in Adams Cove and combined pup production at both rookeries remained lower than the highs recorded in 1997 even though both indices indicated years of increase within the 13-year period. Pup production and mortality have

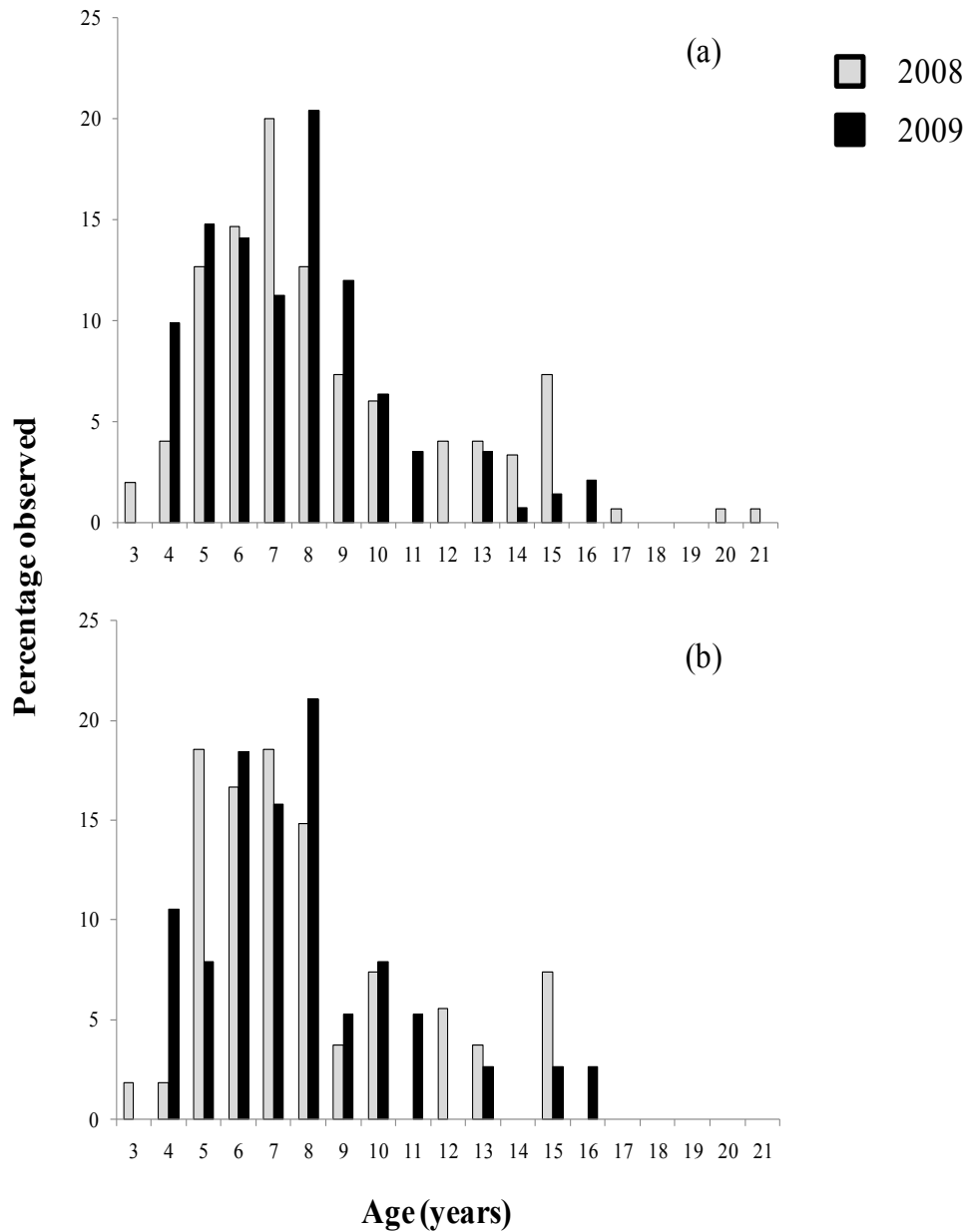


Figure 12.--(a) Percentage of marked adult female northern fur seals of different ages sighted at San Miguel Island, California, during 2008 (n = 150) and 2009 (n = 142) that were tagged as 3-month-old pups between 1989 and 2007. (b) Percentage of marked females of that age that were observed with a pup in 2008 (n = 54) and 2009 (n = 38).

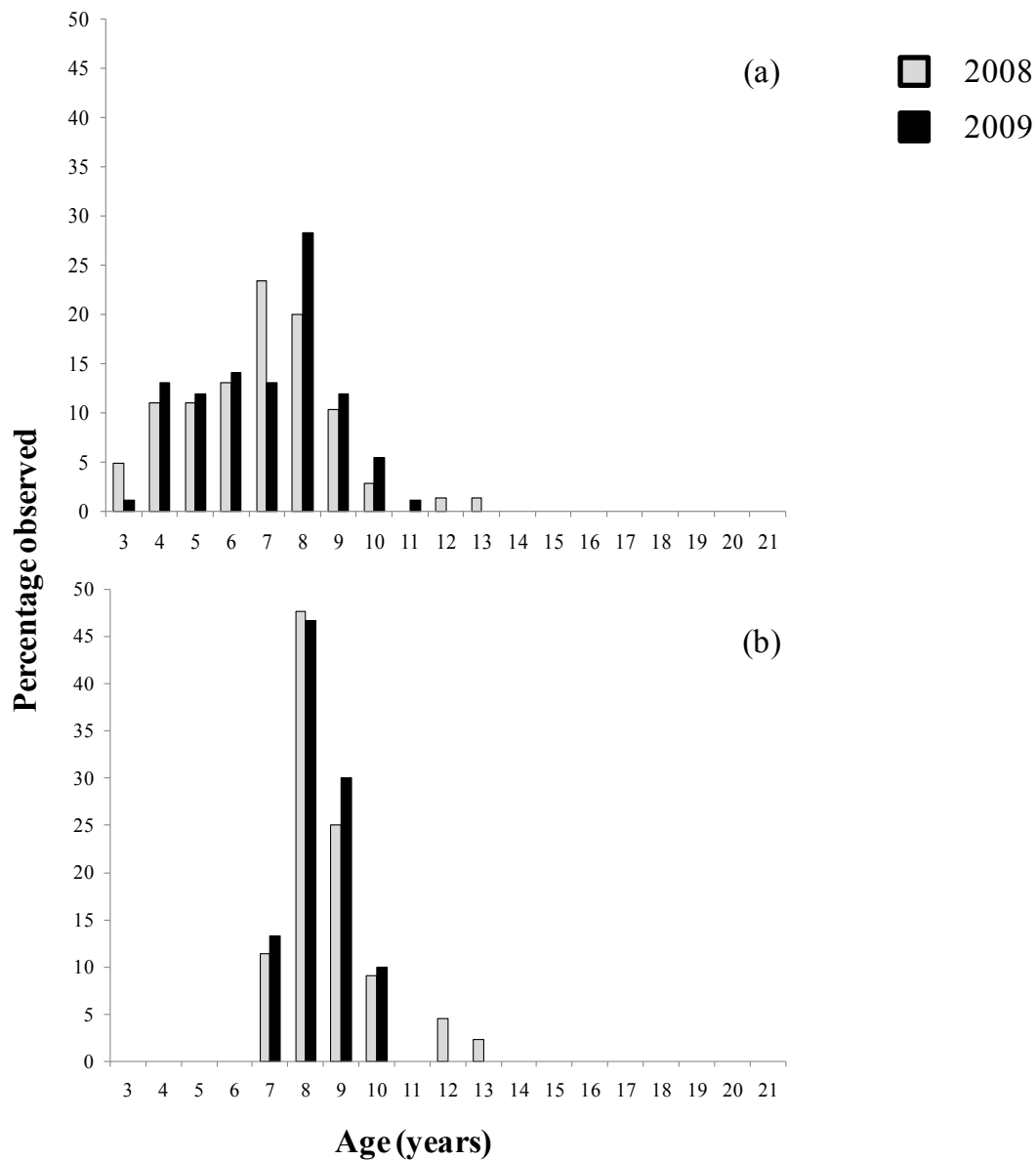


Figure 13. -- (a) Percentage of marked adult male northern fur seals of different ages sighted at San Miguel Island, California, during 2008 (n = 144) and 2009 (n = 92) that were tagged as 3-month-old pups between 1990 and 2007. (b) Percentage of marked bulls of that age that were territorial in 2008 (n = 44) and 2009 (n = 30).

increased during all phases of the PDO. During 2008, pup mortality rate declined significantly from recent years (2004-2007) but this was likely the result of significant numbers of dead pups being washed into the sea before they were counted due to high tides before the first dead pup survey in 2008. The low pup weights recorded during 2008 indicated that pups were in poor condition with mean weights similar to those of pups reared during El Niño conditions and other years when pup mortality rates were high. Therefore, the lower mortality rate observed in 2008 is suspect. During 2009, mean pup weights increased but were lower than expected and represented the third year of the past four years that pups have been in poor condition as they approached weaning. At this time, the cause(s) of the low pup weights is unknown. They may be a consequence of a nutritional deficit acquired during the first six weeks of life due to hookworm infections or they may reflect an unidentified ecosystem process that is affecting the amount of energy available for nursing females to transfer to their pups (e.g., shortage of food, longer foraging trips). However, during most of the study period the PDO was in a “cold” phase when environmental conditions are expected to be favorable for fur seals, so it seems unlikely that a reduction in available energy was the main cause of the mortality. Although anomalously warm coastal ocean conditions were reported during the fur seal reproductive season in 2009 and had dramatic impacts on CSLs at SMI (Melin et al. 2010), the high pup production and high pup mortality rates followed the long-term trend. We believe that northern fur seals should not have been greatly affected by the anomalous conditions, because they normally feed offshore outside the coastal areas that were most greatly affected.

The 1997-1998 El Niño resulted in the near total mortality of the 1997 cohort and low pup production during 1998. This event has resulted in a bimodal age structure with most

animals younger than 10 years of age. However, interpretation of sighting data relative to age-specific mortality is complicated by high tag loss for northern fur seals. The low percentage of older animals represented in the tagged-animal population may represent high tag loss for older animals. Double-tagging studies of northern fur seals were conducted in the Pribilof Islands, Alaska, to estimate tag loss. Results from these studies confirmed that tag loss was significant, with 67% of the pups losing one tag and 3% losing both tags by 3 years of age (Scheffer et al. 1984). Although the studies were based on a different tag type than was used in our study, tag loss has been identified (but not quantified) as a problem with the tags that were used at SMI. Thus, the age structure of the tagged animals is likely biased toward younger animals due to accumulated tag loss for older animals. However, the abrupt decline in the number of territorial bulls and the slow recovery of total births (i.e., fewer reproductive females in the population) after the 1997-1998 El Niño indicates that adult mortality did occur in 1997 and 1998 (Melin and DeLong 2000, Melin et al. 2005). The low number of tagged individuals from the 1997 and 1998 cohorts seen subsequently suggests lower survival (although tag loss must be considered too), and thus lower recruitment of these cohorts into the breeding population in 2000 and 2001. The highest number of tagged animals resighted was from the 2001 cohort, indicating that survival for this cohort was quite good.

Whereas El Niño events represent an external, periodic, density-independent factor affecting the population, hookworm disease is generally a density-dependent factor. Northern fur seal pup mortality associated with hookworm disease occurs within the first six weeks of life. However, residual effects exhibited in survivors include: a weakened immune system, retarded growth, and weight gain once the infection has cleared. Hookworm disease was first described in the SMI northern fur seal population during 1996 (Lyons et al. 1997). In 2000, 95% of the



dead pups less than one month old had hookworm infections (Lyons et al. 2001). We believe that high incidence of hookworm disease in the population has contributed to the high mortality of pups during the past 13 years. We speculate that the high pup mortality will continue until the population mounts an immune response to the parasite, perhaps several generations into the future. Therefore, in addition to environmental perturbations (e.g., El Niño events), disease appears to play an influential role in the population dynamics of the northern fur seals at SMI.



## ACKNOWLEDGMENTS

The fur seal research team extends its special thanks to the communities of St. George Island and St. Paul Island who continuously support our research efforts. We are especially appreciative of the participation of youths from the stewardship program on the Pribilof Islands. The Channel Islands National Park Service provided logistical support for field operations on San Miguel Island. The bulk of our work on the Pribilof and Channel Islands would not be possible without the assistance of numerous volunteers and employees from affiliated universities and institutions (Appendix C). We are also grateful for the professional assistance of Gary Duker, James Lee and Christine Baier; technical editors at the Alaska Fisheries Science Center.



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## APPENDIX A

## Glossary

The terms defined below are used in the chapters of this report on fur seal research and management on the Pribilof Islands, Bogoslof Island, San Miguel Island, and Castle Rock.

Bachelor                                      Young male seals aged 2-5 years

Classification of adult male fur seals

- Class 1  
(shoreline)                                      Full-grown males apparently attached to “territories” spaced along the water’s edge at intervals of 10-15 m. Most of these animals are wet or partly wet, and some acquire harems of one to four females between 10 and 20 July. They would then be called harem males (Class 3). Class 1 males should not be confused with Class 2 animals, which have definite territories, whereas the shoreline males appear to be attached to such sites but may not be in all cases.
- Class 2  
(territorial  
without females)                                      Full-grown males that have no females, but are actively defending territories. Most of these animals are located on the inland fringe of a rookery: some are between Class 1 (shoreline) and Class 3 (territorial with females) males, and a few are completely surrounded by Class 3 males and their harems.
- Class 3  
(territorial  
with females)                                      Full-grown males actively defending territories and females. Most Class 3 males and their harems combine to form a compact mass of animals. Isolated individuals, usually with small harems, may be observed at each end of a rookery, on sandy beaches, and in corridors leading to inland hauling grounds. Some territorial males have as few as one or two females. Should these females be absent during counts, their pups are used as a basis for putting the adult male into Class 3 rather than Class 2.

|                              |   |
|------------------------------|---|
| Class 4<br>(non-territorial) | Full- and partly grown males on the inland fringe of a rookery. A few animals too young and too small to include in the count may be found here. Though some Class 4 males may appear to be holding territories, most will flee when approached or when prodded with a pole.                                |
| Class 5<br>(hauling grounds) | The hauling grounds contain males from May to late July and a mixture of males and females from then on. The counts include males that obviously are adults and all others that have a mane and the body conformation of an adult. Males included in this count are approximately 7 years of age and older. |
| Hauling ground               | An area, usually near a rookery, on which nonbreeding seals congregate. See “Rookery.”  |
| Haul out                     | The act of seals moving from the sea onto shore at either a rookery or hauling ground.  |
| Marked                       | Describes a seal that has been marked by attaching an inscribed metal or plastic tag to one or more of its flippers, by hair clipping, or by bleaching.   |
| Mark recoveries              | Recovery (sighting) of a seal that has been marked by one of several methods. See “Marked.”   |
| Rookery                      | An area on which breeding seals congregate. See ‘Hauling ground.’   |

## APPENDIX B

Tabulations of northern fur seal adults and pups counted by rookery, size class, and rookery section during population assessment.

Table B-1.--Number of adult male northern fur seals counted, by class and rookery section, St. Paul Island, Alaska, 9-15 July 2008.

Table B-2.--Number of adult male northern fur seals counted, by class and rookery section, St. Paul Island, Alaska, 8-14 July 2009.

Table B-3.--Number of northern fur seal pups sheared on each sampled rookery of St. Paul Island, Alaska, 2008.

Table B-4.--Number of harem and idle males, pups born, number of rookeries sampled, standard deviation (SD) of the number of pups born, and the number of dead pups on the Pribilof Islands, Alaska, 1981-2009.

Table B-5.--Number of dead northern fur seal pups counted by section on the sampled rookeries of St. Paul Island, Alaska, 2008.

Table B-6.--Number of northern fur seal pups sheared on each rookery, St. George Island, Alaska, 2008.

Table B-7.--Number of dead northern fur seal pups counted by section on the rookeries of St. George Island, Alaska, 2008.

Table B-8.--Number of dead northern fur seals counted that were older than pups, Pribilof Islands, Alaska, 1973-2008.



Table B-1. – Number of adult male northern fur seals counted (rounded average of two counts), by class<sup>a</sup> and rookery section, St. Paul Island, Alaska, 9-15 July 2008. A dash indicates no section.

| Rookery and class of male  | Section  |     |    |    |     |    |    |     |    |     |    |    |     |      | Total |     |
|----------------------------|----------|-----|----|----|-----|----|----|-----|----|-----|----|----|-----|------|-------|-----|
|                            | 1        | 2   | 3  | 4  | 5   | 6  | 7  | 8   | 9  | 10  | 11 | 12 | 13  | 14   |       |     |
| <u>Lukanin</u>             |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 16       | 20  |    |    |     |    |    |     |    |     |    |    |     |      |       | 36  |
| 3                          | 47       | 37  |    |    |     |    |    |     |    |     |    |    |     |      |       | 84  |
| 5                          | 141      | 11  |    |    |     |    |    |     |    |     |    |    |     |      |       | 152 |
| <u>Kitovi<sup>b</sup></u>  |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | (1) 6    | 12  | 8  | 24 | 14  |    |    |     |    |     |    |    |     |      |       | 65  |
| 3                          | (16) 10  | 31  | 27 | 36 | 38  |    |    |     |    |     |    |    |     |      |       | 158 |
| 5                          | (40) 7   | 9   | 9  | 17 | 85  |    |    |     |    |     |    |    |     |      |       | 167 |
| <u>Reef</u>                |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 20       | 29  | 14 | 15 | 29  | 13 | 12 | 18  | 10 | 12  | 3  |    |     |      |       | 175 |
| 3                          | 42       | 86  | 53 | 43 | 60  | 60 | 3  | 70  | 41 | 26  | 7  |    |     |      |       | 491 |
| 5                          | 17       | 49  | 37 | 22 | 68  | 11 | 24 | 26  | 18 | 184 | 13 |    |     |      |       | 469 |
| <u>Gorbatch</u>            |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 23       | 10  | 21 | 7  | 8   | 4  |    |     |    |     |    |    |     |      |       | 73  |
| 3                          | 79       | 56  | 72 | 17 | 49  | 68 |    |     |    |     |    |    |     |      |       | 341 |
| 5                          | 294      | 17  | 40 | 46 | 14  | 17 |    |     |    |     |    |    |     |      |       | 428 |
| <u>Ardiguin</u>            |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 10       |     |    |    |     |    |    |     |    |     |    |    |     |      |       | 10  |
| 3                          | 65       |     |    |    |     |    |    |     |    |     |    |    |     |      |       | 65  |
| 5                          | 6        |     |    |    |     |    |    |     |    |     |    |    |     |      |       | 6   |
| <u>Morjovi<sup>c</sup></u> |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | (16) 16  | 8   | 18 | 11 | 22  | 18 |    |     |    |     |    |    |     |      |       | 109 |
| 3                          | (51) 49  | 54  | 48 | 28 | 64  | 50 |    |     |    |     |    |    |     |      |       | 344 |
| 5                          | (16) 252 | 55  | 20 | 11 | 34  | 75 |    |     |    |     |    |    |     |      |       | 463 |
| <u>Vostochni</u>           |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 4        | 2   | 17 | 5  | 12  | 31 | 7  | 7   | 12 | 4   | 8  | 13 | 14  | 29   |       | 155 |
| 3                          | 52       | 26  | 27 | 52 | 35  | 71 | 37 | 49  | 39 | 24  | 30 | 62 | 185 | 261* |       | 959 |
| 5                          | 19       | 8   | 9  | 26 | 102 | 22 | 20 | 12  | 17 | 7   | 8  | 35 | 102 | 180  |       | 561 |
| <u>Little Polovina</u>     |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 0        |     |    |    |     |    |    |     |    |     |    |    |     |      |       | 0   |
| 3                          | 3        |     |    |    |     |    |    |     |    |     |    |    |     |      |       | 3   |
| 5                          | 186      |     |    |    |     |    |    |     |    |     |    |    |     |      |       | 186 |
| <u>Polovina</u>            |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 10       | 12  |    |    |     |    |    |     |    |     |    |    |     |      |       | 22  |
| 3                          | 57       | 51  |    |    |     |    |    |     |    |     |    |    |     |      |       | 108 |
| 5                          | 115      | 24  |    |    |     |    |    |     |    |     |    |    |     |      |       | 139 |
| <u>Polovina Cliffs</u>     |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 11       | 3   | 10 | 14 | 12  | 28 | 8  |     |    |     |    |    |     |      |       | 86  |
| 3                          | 55       | 24  | 23 | 49 | 55  | 91 | 89 |     |    |     |    |    |     |      |       | 386 |
| 5                          | 31       | 10  | 7  | 17 | 13  | 20 | 11 |     |    |     |    |    |     |      |       | 109 |
| <u>Tolstoi</u>             |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 11       | 12  | 9  | 10 | 29  | 22 | 30 | 34  |    |     |    |    |     |      |       | 157 |
| 3                          | 31       | 31  | 26 | 52 | 56  | 64 | 52 | 51  |    |     |    |    |     |      |       | 363 |
| 5                          | 4        | 6   | 7  | 8  | 24  | 13 | 31 | 178 |    |     |    |    |     |      |       | 271 |
| <u>Zapadni Reef</u>        |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 58       | 19  |    |    |     |    |    |     |    |     |    |    |     |      |       | 77  |
| 3                          | 111      | 35  |    |    |     |    |    |     |    |     |    |    |     |      |       | 146 |
| 5                          | 63       | 110 |    |    |     |    |    |     |    |     |    |    |     |      |       | 173 |
| <u>Little Zapadni</u>      |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 5        | 14  | 26 | 33 | 29  | 25 |    |     |    |     |    |    |     |      |       | 132 |
| 3                          | 16       | 36  | 40 | 49 | 41  | 59 |    |     |    |     |    |    |     |      |       | 241 |
| 5                          | 17       | 17  | 9  | 17 | 9   | 95 |    |     |    |     |    |    |     |      |       | 164 |
| <u>Zapadni</u>             |          |     |    |    |     |    |    |     |    |     |    |    |     |      |       |     |
| 2                          | 12       | 12  | 18 | 16 | 20  | 19 | 36 | 12  |    |     |    |    |     |      |       | 145 |
| 3                          | 33       | 46  | 50 | 64 | 56  | 76 | 68 | 37  |    |     |    |    |     |      |       | 430 |
| 5                          | 106      | 9   | 8  | 24 | 30  | 23 | 38 | 282 |    |     |    |    |     |      |       | 520 |

<sup>a</sup> Class 2 = territorial adult male without female; class 3 = territorial adult male with female; class 5 = non-territorial adult male.

<sup>b</sup> Numbers in parentheses are the adult males counted in Kitovi Amphitheater.

<sup>c</sup> Numbers in parenthesis are the adult males counted on the second point south of Sea Lion Neck.

\* There was a potential error in the harem male counts in section 14. The counter believes that they may not have cleared their counter from the counts in section 13 prior to 14. Since this came to light just prior to publication we have provided details here. The suspicion is that the count should be 76 (261-185) but neither count can be verified at this time.

Table B-2. – Number of adult male northern fur seals counted (rounded average of two counts), by class<sup>a</sup> and rookery section, St. Paul Island, Alaska, 8-14 July 2009. A dash indicates no section.

| Rookery and class of male  | Section  |    |    |    |    |     |    |     |    |    |    |    |     |     | Total |
|----------------------------|----------|----|----|----|----|-----|----|-----|----|----|----|----|-----|-----|-------|
|                            | 1        | 2  | 3  | 4  | 5  | 6   | 7  | 8   | 9  | 10 | 11 | 12 | 13  | 14  |       |
| <u>Lukanin</u>             |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 21       | 11 |    |    |    |     |    |     |    |    |    |    |     |     | 3     |
| 3                          | 89       | 56 |    |    |    |     |    |     |    |    |    |    |     |     | 145   |
| 5                          | 114      | 8  |    |    |    |     |    |     |    |    |    |    |     |     | 122   |
| <u>Kitovi</u>              |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 6        | 6  | 12 | 10 | 13 |     |    |     |    |    |    |    |     |     | 47    |
| 3                          | 28       | 61 | 50 | 44 | 57 |     |    |     |    |    |    |    |     |     | 240   |
| 5                          | 34       | 7  | 8  | 12 | 98 |     |    |     |    |    |    |    |     |     | 159   |
| <u>Reef</u>                |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 9        | 29 | 18 | 6  | 13 | 20  | 8  | 16  | 17 | 13 | 2  |    |     |     | 151   |
| 3                          | 36       | 67 | 56 | 39 | 46 | 81  | 6  | 71  | 56 | 39 | 4  |    |     |     | 501   |
| 5                          | 17       | 34 | 26 | 27 | 37 | 11  | 14 | 34  | 32 | 76 | 34 |    |     |     | 342   |
| <u>Gorbatch</u>            |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 38       | 31 | 30 | 8  | 24 | 19  |    |     |    |    |    |    |     |     | 150   |
| 3                          | 75       | 48 | 58 | 23 | 58 | 62  |    |     |    |    |    |    |     |     | 324   |
| 5                          | 327      | 22 | 42 | 36 | 19 | 19  |    |     |    |    |    |    |     |     | 465   |
| <u>Ardiguin</u>            |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 7        |    |    |    |    |     |    |     |    |    |    |    |     |     | 7     |
| 3                          | 66       |    |    |    |    |     |    |     |    |    |    |    |     |     | 66    |
| 5                          | 14       |    |    |    |    |     |    |     |    |    |    |    |     |     | 14    |
| <u>Morjovi<sup>b</sup></u> |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | (18) 18  | 16 | 19 | 9  | 24 | 18  |    |     |    |    |    |    |     |     | 122   |
| 3                          | (49) 51  | 67 | 56 | 29 | 76 | 52  |    |     |    |    |    |    |     |     | 380   |
| 5                          | (15) 191 | 32 | 21 | 14 | 35 | 44  |    |     |    |    |    |    |     |     | 352   |
| <u>Vostochni</u>           |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 11       | 7  | 6  | 13 | 22 | 20  | 18 | 15  | 11 | 8  | 8  | 14 | 38  | 26  | 217   |
| 3                          | 52       | 26 | 35 | 52 | 34 | 69  | 33 | 47  | 31 | 20 | 35 | 62 | 149 | 82  | 727   |
| 5                          | 18       | 13 | 6  | 15 | 66 | 9   | 11 | 22  | 30 | 9  | 5  | 91 | 128 | 190 | 613   |
| <u>Little Polovina</u>     |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 5        |    |    |    |    |     |    |     |    |    |    |    |     |     | 5     |
| 3                          | 1        |    |    |    |    |     |    |     |    |    |    |    |     |     | 1     |
| 5                          | 212      |    |    |    |    |     |    |     |    |    |    |    |     |     | 212   |
| <u>Polovina</u>            |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 17       | 12 |    |    |    |     |    |     |    |    |    |    |     |     | 29    |
| 3                          | 53       | 44 |    |    |    |     |    |     |    |    |    |    |     |     | 97    |
| 5                          | 195      | 36 |    |    |    |     |    |     |    |    |    |    |     |     | 231   |
| <u>Polovina Cliffs</u>     |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 21       | 4  | 7  | 6  | 22 | 22  | 26 |     |    |    |    |    |     |     | 108   |
| 3                          | 41       | 23 | 28 | 59 | 43 | 63  | 85 |     |    |    |    |    |     |     | 342   |
| 5                          | 39       | 13 | 2  | 13 | 15 | 28  | 11 |     |    |    |    |    |     |     | 121   |
| <u>Tolstoi</u>             |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 13       | 10 | 4  | 2  | 14 | 39  | 28 | 23  |    |    |    |    |     |     | 133   |
| 3                          | 36       | 29 | 38 | 61 | 61 | 81  | 50 | 74  |    |    |    |    |     |     | 430   |
| 5                          | 5        | 5  | 8  | 13 | 8  | 13  | 34 | 118 |    |    |    |    |     |     | 204   |
| <u>Zapadni Reef</u>        |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 55       | 12 |    |    |    |     |    |     |    |    |    |    |     |     | 67    |
| 3                          | 145      | 30 |    |    |    |     |    |     |    |    |    |    |     |     | 175   |
| 5                          | 89       | 94 |    |    |    |     |    |     |    |    |    |    |     |     | 183   |
| <u>Little Zapadni</u>      |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 2        | 23 | 32 | 32 | 31 | 24  |    |     |    |    |    |    |     |     | 144   |
| 3                          | 21       | 47 | 50 | 52 | 41 | 62  |    |     |    |    |    |    |     |     | 273   |
| 5                          | 13       | 29 | 13 | 39 | 39 | 146 |    |     |    |    |    |    |     |     | 279   |
| <u>Zapadni<sup>c</sup></u> |          |    |    |    |    |     |    |     |    |    |    |    |     |     |       |
| 2                          | 11       | 14 | 21 | 25 | 39 | 41  | 48 | 25  |    |    |    |    |     |     | 224   |
| 3                          | 36       | 35 | 48 | 48 | 69 | 80  | 63 | 41  |    |    |    |    |     |     | 420   |
| 5                          | (42) 30  | 11 | 25 | 25 | 19 | 55  | 30 | 256 |    |    |    |    |     |     | 493   |

<sup>a</sup> Class 2 = territorial adult male without female; class 3 = territorial adult male with female; class 5 = non-territorial adult male.

<sup>b</sup> Numbers in parenthesis are the adult males counted on the second point south of Sea Lion Neck.

<sup>c</sup> Numbers in parenthesis are the adult males counted on Zapadni Point Reef.



Table B-3.-- Number of northern fur seal pups sheared on each sampled rookery of St. Paul Island, Alaska, 2008.

| Rookery              | Section |     |     |     |     |     |     |     |     |     |    |    |     |     | Total |        |
|----------------------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-------|--------|
|                      | 0       | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10 | 11 | 12  | 13  |       | 14     |
| Lukanin              |         | 156 | 129 |     |     |     |     |     |     |     |    |    |     |     |       | 285    |
| Kitovi <sup>1</sup>  | 17      | 27  | 64  | 89  | 101 | 101 |     |     |     |     |    |    |     |     |       | 399    |
| Reef <sup>2</sup>    |         | 121 | 232 | 148 | 128 | 175 | 169 |     | 196 | 134 | 76 | 4  |     |     |       | 1,383  |
| Gorbatch             |         | 212 | 158 | 199 | 42  | 121 | 176 |     |     |     |    |    |     |     |       | 908    |
| Ardiguen             |         | 97  |     |     |     |     |     |     |     |     |    |    |     |     |       | 97     |
| Morjovi <sup>1</sup> | 138     | 126 | 146 | 133 | 77  | 183 | 126 |     |     |     |    |    |     |     |       | 929    |
| Vostochni            |         | 96  | 53  | 64  | 100 | 67  | 156 | 75  | 82  | 69  | 44 | 58 | 105 | 335 | 229   | 1,533  |
| Polovina             |         | 167 | 102 |     |     |     |     |     |     |     |    |    |     |     |       | 269    |
| Little Polovina      |         |     |     |     |     |     |     |     |     |     |    |    |     |     |       |        |
| Polovina Cliffs      |         | 146 | 66  | 61  | 153 | 125 | 189 | 261 |     |     |    |    |     |     |       | 1,001  |
| Tolstoi              |         | 85  | 98  | 87  | 155 | 175 | 209 | 160 | 170 |     |    |    |     |     |       | 1,139  |
| Zapadni Reef         |         | 364 | 179 |     |     |     |     |     |     |     |    |    |     |     |       | 543    |
| Little Zapadni       |         | 48  | 150 | 148 | 194 | 145 | 224 |     |     |     |    |    |     |     |       | 909    |
| Zapadni              |         | 90  | 144 | 167 | 183 | 187 | 243 | 223 | 80  |     |    |    |     |     |       | 1,317  |
| Sea Lion Rock        |         | 567 |     |     |     |     |     |     |     |     |    |    |     |     |       | 567    |
| Total                |         |     |     |     |     |     |     |     |     |     |    |    |     |     |       | 11,279 |

<sup>1</sup>Section 0 corresponds to 2nd Point South on Morjovi and Kitovi Amphitheater.

<sup>2</sup> Section 7 was combined with Section 6.

Table B-4. -- Number of harem and idle males, pups born, number of rookeries sampled, standard deviation (SD) of the number of pups born, and the number of dead pups on the Pribilof Island, Alaska, 1981-2009. A dash indicates no data.

| Year | St. Paul           |            |           |        | St. George            |                    |             |            |           |       |                   |                  |
|------|--------------------|------------|-----------|--------|-----------------------|--------------------|-------------|------------|-----------|-------|-------------------|------------------|
|      | Harem Bulls        | Idle Bulls | Pups Born | SD     | Rookeries Sampled (n) | Dead Pups          | Harem Bulls | Idle Bulls | Pups Born | SD    | Rookeries Sampled | Dead Pups        |
| 1981 | 5,120              | 4,003      | 179,444   | 5,876  | 4                     | 6,798              | 1,472       | 1,646      | 38,152    | 1,581 | 6                 | 2,025            |
| 1982 | 5,767              | 4,009      | 203,581   | 3,482  | 4                     | 7,301              | 1,410       | 1,319      | --        | --    | --                | 1,600            |
| 1983 | 4,827              | 4,242      | 165,941   | 6,034  | 4                     | 5,997              | --          | --         | 31,440    | 2,930 | 6                 | 903              |
| 1984 | 4,803              | 3,977      | 173,274   | 8,117  | 5                     | 6,115              | 1,473       | 1,452      | --        | --    | --                | --               |
| 1985 | 4,372              | 3,363      | 182,258   | 7,997  | 7                     | 5,266              | 1,268       | 1,601      | 28,869    | 2,297 | 6                 | 806              |
| 1986 | 4,603              | 1,865      | 167,656   | 5,086  | 4                     | 7,771              | 1,394       | 1,342      | --        | --    | --                | --               |
| 1987 | 3,636              | 1,892      | 171,610   | 3,218  | 13                    | 7,757              | 1,303       | 1,283      | --        | --    | --                | --               |
| 1988 | 3,585              | 3,201      | 202,229   | 3,751  | 4                     | 7,272              | 1,259       | 1,258      | 24,820    | 827   | 6                 | 1,212            |
| 1989 | 4,297              | 6,400      | 171,534   | 25,867 | 4                     | 9,096              | 1,241       | 1,163      | --        | --    | --                | --               |
| 1990 | 4,430              | 7,629      | 201,305   | 3,724  | 13                    | 9,128              | 909         | 1,666      | 23,397    | 2,054 | 6                 | 928              |
| 1991 | 4,729              | 9,453      | --        | --     | --                    | --                 | 736         | 1,271      | --        | --    | --                | --               |
| 1992 | 5,460              | 10,940     | 182,437   | 8,918  | 13                    | 8,525              | 1,029       | 1,834      | 25,160    | 707   | 6                 | 806              |
| 1993 | 6,405              | 9,301      | --        | --     | --                    | --                 | 1,123       | 1,422      | --        | --    | --                | --               |
| 1994 | 5,715              | 10,014     | 192,104   | 2,029  | 13                    | 8,180              | 1,179       | 1,481      | 22,244    | 410   | 6                 | 788              |
| 1995 | 5,154              | 8,459      | --        | --     | --                    | --                 | 1,242       | 1,054      | --        | --    | --                | --               |
| 1996 | 5,643              | 9,239      | 170,125   | 21,244 | 6                     | 6,837 <sup>1</sup> | 1,248       | 790        | 27,385    | 294   | 6                 | 719              |
| 1997 | 5,064              | 8,560      | --        | --     | --                    | --                 | 910         | 1,474      | --        | --    | --                | --               |
| 1998 | 4,762              | 8,396      | 179,149   | 6,193  | 7                     | 5,058 <sup>1</sup> | 1,116       | 1,084      | 22,090    | 222   | 6                 | 452              |
| 1999 | 3,767              | 7,589      | --        | --     | --                    | --                 | 1,052       | 916        | --        | --    | --                | --               |
| 2000 | 3,646              | 6,998      | 158,736   | 17,284 | 6                     | 4,778 <sup>1</sup> | 871         | 1,300      | 20,176    | 271   | 6                 | 756              |
| 2001 | 3,388              | 7,174      | --        | --     | --                    | --                 | 843         | 1,596      | --        | --    | --                | --               |
| 2002 | 3,669              | 7,877      | 145,716   | 1,629  | 13                    | 4,790              | 899         | 1,265      | 17,593    | 527   | 6                 | 533              |
| 2003 | 3,652              | 7,572      | --        | --     | --                    | --                 | 716         | 1,158      | --        | --    | --                | --               |
| 2004 | 3,286              | 5,027      | 122,825   | 1,290  | 13                    | 4,041              | 760         | 905        | 16,878    | 239   | 6                 | 417              |
| 2005 | 3,515              | 5,811      | --        | --     | --                    | --                 | 905         | 634        | --        | --    | --                | --               |
| 2006 | 3,669              | 6,283      | 109,961   | 1,520  | 13                    | 4,994 <sup>2</sup> | 720         | 650        | 17,072    | 143   | 6                 | 712 <sup>2</sup> |
| 2007 | 3,568              | 5,270      | --        | --     | --                    | --                 | 744         | 559        | --        | --    | --                | --               |
| 2008 | 4,119 <sup>3</sup> | 5,050      | 102,674   | 1,084  | 13                    | 5,497 <sup>2</sup> | 805         | 638        | 18,160    | 288   | 6                 | 986              |
| 2009 | 4,121              | 5,226      | --        | --     | --                    | --                 | 873         | 824        | --        | --    | --                | --               |

<sup>1</sup> Dead pups for the entire Island are estimated from the mortality rate on sampled rookeries.

<sup>2</sup> Total dead pups are estimated from dead pup counts on sample rookeries, different protocol than <sup>1</sup>.

<sup>3</sup> Error in bull counts, see Appendix Table B-1 for details on Vostochni, section 14.



Table B-6. -- Number of northern fur seal pups sheared on each rookery of St. George Island, Alaska, 2008.

| Rookery       | Section |     |     |    |    | Total |
|---------------|---------|-----|-----|----|----|-------|
|               | 1       | 2   | 3   | 4  | 5  |       |
| South         | 126     | 131 | 146 |    |    | 403   |
| North         | 120     | 151 | 189 | 94 | 54 | 608   |
| East Reef     | 133     |     |     |    |    | 133   |
| East Cliffs   | 265     | 134 |     |    |    | 399   |
| Staraya Artil | 90      | 16  |     |    |    | 106   |
| Zapadni       | 56      | 123 | 64  |    |    | 243   |
| Total         |         |     |     |    |    | 1,892 |

Table B-7. -- Number of dead northern fur seal pups counted by section on the rookeries of St. George Island, Alaska, 2008.

| Rookery   | Date | Section |     |     |   |    | Total |     |
|-----------|------|---------|-----|-----|---|----|-------|-----|
|           |      | 1       | 2   | 3   | 4 | 5  |       |     |
| North     | 8/21 | 51      | 121 | 103 |   | 38 | 32    | 345 |
| East Reef | 8/19 | 48      |     |     |   |    |       | 48  |
| Zapadni   | 8/20 | 39      | 45  | 22  |   |    |       | 106 |

Table B-8. -- Number of dead northern fur seals counted that were older than pup, Pribilof Islands, Alaska, 1973-2008. Teeth (usually canines) were collected from most of these seals. A dash indicates no data.

| Year              | St. Paul Island |                  | St. George Island |                 | Total |                  |
|-------------------|-----------------|------------------|-------------------|-----------------|-------|------------------|
|                   | Males           | Females          | Males             | Females         | Males | Females          |
| 1973              | 61              | 65               | 7                 | 30              | 68    | 95               |
| 1974              | 33              | 30               | 4                 | 15              | 37    | 45               |
| 1975              | 92              | 99               | -                 | -               | 92    | 99               |
| 1976              | 46              | 64               | -                 | -               | 46    | 64               |
| 1977              | 60              | 69               | -                 | -               | 60    | 69               |
| 1978              | 57              | 87               | -                 | -               | 57    | 87               |
| 1979              | 56              | 66               | - <sup>a</sup>    | - <sup>a</sup>  | 56    | 66               |
| 1980              | 102             | 117              | 14                | 65              | 116   | 182              |
| 1981              | 44              | 83               | 12                | 61              | 56    | 144              |
| 1982              | 47              | 117              | -                 | -               | 47    | 117              |
| 1983              | 57              | 66               | -                 | -               | 57    | 66               |
| 1984              | 66              | 72               | -                 | -               | 66    | 72               |
| 1985              | 5               | 34               | 17                | 35              | 22    | 69               |
| 1986              | 24              | 67               | -                 | -               | 24    | 67               |
| 1987              | 20              | 90 <sup>b</sup>  | -                 | -               | 20    | 99               |
| 1988              | 56              | 112              | 21                | 29              | 77    | 141              |
| 1989              | 55              | 162              | -                 | -               | 55    | 162              |
| 1990              | 97              | 151              | 13                | 31              | 110   | 182              |
| 1992              | 97              | 265              | 7                 | 19              | 104   | 284              |
| 1994              | 84              | 223 <sup>c</sup> | 6                 | 19 <sup>d</sup> | 90    | 242              |
| 1996              | 20 <sup>e</sup> | 92 <sup>e</sup>  | 3                 | 20 <sup>f</sup> | 23    | 112 <sup>f</sup> |
| 1998 <sup>g</sup> | -               | -                | -                 | -               | -     | -                |
| 2000              | 20              | 77               | 26                | 98              | 46    | 175              |
| 2002 <sup>h</sup> | 36              | 107              | 6                 | 19              | 42    | 126              |
| 2004 <sup>i</sup> | 37              | 85               | 9                 | 12              | 46    | 97               |
| 2006 <sup>j</sup> | 23              | 37               | 2                 | 8               | 25    | 45               |
| 2008 <sup>j</sup> | 4               | 41               | 2                 | 10              | 6     | 51               |

<sup>a</sup> A total of 70 dead adult fur seals of both sexes were counted on the rookeries of St. George Island.

<sup>b</sup> Includes 10 dead adult fur seals of unknown sex.

<sup>c</sup> Includes 16 dead adult fur seals of unknown sex.

<sup>d</sup> Includes 2 dead adult fur seals of unknown sex.

<sup>e</sup> Counts made only on the 6 sample rookeries where dead pups were counted.

<sup>f</sup> Includes 16 dead adult fur seals of unknown sex.

<sup>g</sup> A total of 108 dead adults were counted on St. Paul Island and 34 dead adults were counted on St. George Island.

<sup>h</sup> Does not include 8 dead adults that were unidentifiable, had no teeth and both.

<sup>i</sup> Does not include 11 dead adults that were not sexually identifiable.

<sup>j</sup> Only four rookeries were sampled for dead pups and therefore dead adults also.

## APPENDIX C

Scientific Staff Engaged in Northern Fur Seal  
Field Research in 2008-2009

National Marine Mammal Laboratory  
 John L. Bengtson, Director  
 Tom Gelatt, Leader, Alaska Ecosystem Program  
 Rolf R. Ream, Northern Fur Seal Task

| <u>Employees &amp; Volunteers</u> | <u>Affiliation</u> |
|-----------------------------------|--------------------|
| Jason Baker                       | NMML               |
| John Bengtson                     | NMML               |
| Kate Call                         | NMML               |
| Bob Caruso                        | NMML               |
| Robert DeLong                     | NMML               |
| Bobette Dickerson                 | NMML               |
| Caroline Dorr                     | NMML               |
| Brian Fadely                      | NMML               |
| Sara Finniseth                    | NMML               |
| Tom Gelatt                        | NMML               |
| Sarah Gutzwiller                  | NMML               |
| Jeff Harris                       | NMML               |
| Devin Johnson                     | NMML               |
| Carey Kuhn                        | NMML               |
| Sharon Melin                      | NMML               |
| Anthony Orr                       | NMML               |
| Greg Orr                          | NMML               |
| Rolf Ream                         | NMML               |
| Matt Rutishauser                  | NMML               |
| Beth Sinclair                     | NMML               |
| Rebecca Steele                    | NMML               |
| Jeremy Sterling                   | NMML               |
| Katie Sweeny                      | NMML               |
| Louise Taylor                     | NMML               |
| Ward Testa                        | NMML               |
| Jim Thomason                      | NMML               |
| Mike Tift                         | NMML               |
| Rod Towell                        | NMML               |
| Tonya Zeppelin                    | NMML               |

Research Associates and Cooperators

|                    |            |
|--------------------|------------|
| Gregg Adams        | WCVM       |
| Don Bergfelt       | EPA        |
| Darlene DeGhetto   | DVM        |
| Heather Harris     | MMC        |
| Juan Leon Guerrero | NMFSA      |
| Dustin Jones       | TGSP       |
| Erin Kunisch       | OSU        |
| Phillip Lekanof    | SGTC       |
| Stephen Meck       | OSU        |
| John R. Melovidov  | PISP       |
| Paul Melovidov     | TGSP       |
| Chris Mercurief    | SGTC       |
| Brett Miller       | OSU        |
| Feliciaca Nutter   | MMC        |
| Brad Page          | SARDI      |
| Patrick Pomeroy    | SMRU       |
| Terry Spraker      | WPI        |
| Kent Sundseth      | NMFS/USFWS |
| Michael Williams   | NMFSA      |
| Chelsea Zacharof   | PISP       |
| Samantha Zacharof  | PISP       |
| Phillip Zavadil    | TGSP       |

Affiliation Codes

DVM – Contract Veterinarian

EPA – Environmental Protection Agency, Washington, DC

MMC – Marine Mammal Center, California

NMFS - National Marine Fisheries Service

NMFSA - National Marine Fisheries Service Regional Office, Anchorage, Alaska

NMML - National Marine Mammal Laboratory

OSU – Oregon State University

SARDI – South Australian Research and Development Institute

SMRU – Sea Mammal Research Unit, Scotland

PISP - Pribilof Island Stewardship Program

SGTC – St. George Tribal Council

TGSP - Tribal Government of St. Paul, St. Paul Island, Alaska

USFWS - U.S. Fish and Wildlife Service, Alaska Maritime Wildlife Refuge

WCVM – Western College of Veterinary Medicine, University of Saskatchewan

WPI - Wildlife Pathology International



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