Appendix A. Raw data tables

Table A1. The raw data used for the central Gulf of Alaska.

Year	Non-pup count	Pup count[1]	*J/T* metric[6]	Sample size for *J/T* metric # of measurements (# of haul-outs)
1976	24678[2]	no data	no data	n.a.
1977	no data	no data	no data	n.a.
1978	27155[7]	17835	no data	n.a.
1979	28460[7]	19886	no data	n.a.
1980	no data	no data	no data	n.a.
1981	no data	no data	no data	n.a.
1982	no data	no data	no data	n.a.
1983	no data	no data	no data	n.a.
1984	no data	15019	no data	n.a.
1985	19002[2]	no data	0.3788	7182 (13)
1986	no data	11598	no data	n.a.
1987	no data	no data	no data	n.a.
1988	no data	no data	no data	n.a.
1989	8552[2]	6394	0.4843	3039 (11)
1990	7050[2]	4648	0.5025	2752 (16)
1991	6273[2]	4057	0.4801	2468 (16)
1992	5721[2]	3646	0.5255	2409 (19)
1993	no data	3176	no data	n.a.
1994	4520[3]	2831	0.3706	2536 (19)
1995	no data	no data	no data	n.a.
1996	3915[3]	no data	0.3698	1971 (17)
1997	3352[3]	2056	0.4007	1924 (15)
1998	3467[4]	1876	0.4095	2090 (16)
1999	no data	no data	no data	n.a.
2000	3180[4]	1675	0.4769	2489 (17)
2001	no data	1540	no data	n.a.
2002	3366[4]	1608	0.4483	2237 (18)
2003	no data	no data	no data	n.a.
2004	3055[5]	1578	no data	n.a.

1. Based on the sum of the Marmot, Sugarloaf, Chowiet, Chirokof, and Outer Island rookery's pup counts. Table 8 in Fritz, L. W. and C. Stinchcomb. 2005. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) in the western stock in Alaska, June and July 2003 and 2004. U.S. Department of Commerce., NOAA Tech.

Memo. NMFS-AFSC-153, 56 p. and Sease, J. L., J. P. Lewis, D. C. McAllister, R. L. Merrick and S. M. Mello. 1993. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) in Southeast Alaska, the Gulf of Alaska, and Aleutian Islands during June and July 1992. U.S. Department of Commerce., NOAA Tech. Memo. NMFS-AFSC-17, per interpolation discussed in supplementary methods. The 1978 Outer Island, pup count was interpolated (interpolated value = 843) since the actual count was a rough estimate from a boat rather than a ground count.

2. The nonpup count here is the nonpup count for trend rookeries and haulouts. Table 4 in Sease, J. L., J. P. Lewis, D. C. McAllister, R. L. Merrick and S. M. Mello. 1993. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) in Southeast Alaska, the Gulf of Alaska, and Aleutian Islands during June and July 1992. U.S. Department of Commerce., NOAA Tech. Memo. NMFS-AFSC-17.

3. Table 4 in Sease, J. L., and T. R. Loughlin. 1999. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 1997 and 1998. U.S. Department of Commerce., NOAA Tech. Memo. NMFS-AFSC-100.

4. Table 3 in Sease, J. L., and C. J. Gudmundson. 2002. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) from the western stock in Alaska, June and July 2001 and 2002. U.S. Department of Commerce., NOAA Tech. Memo. NMFS-AFSC-100.

5. Table 4 in Fritz, L. W. and C. Stinchcomb. 2005. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) in the western stock in Alaska, June and July 2003 and 2004. U.S. Department of Commerce., NOAA Tech. Memo. NMFS-AFSC-153. This is the count adjusted for the increased accuracy of the new medium-format

photography which replaced the 35mm photographs used previously. This adjustment is based on a cross-validation discussed in Fritz and Stinchcomb (2005). The unadjusted count was 2944.

6. The *J/T* measurement method was initially presented in Holmes and York (2003). The measurements listed here do not exactly match those in Holmes and York (2003) since more haul-out measurements were taken to supplement those used in that paper.
7. Interpolated based on rookery only counts these years.

Table A2. The raw data used for the western Gulf of Alaska. Footnote references are the same as for Table A1 except where supplemental information is added below table.

Year	Non-pup count	Pup count[1]	*J/T* metric[6]	Sample size for *J/T* metric # of measurements (# of haul-outs)
1976	8311[2]	no data	no data	n.a.
1977	no data	no data	no data	n.a.
1978	15229[7]	no data	no data	n.a.
1979	12128[7]	9351	no data	n.a.
1980	no data	no data	no data	n.a.
1981	no data	no data	no data	n.a.
1982	no data	no data	no data	n.a.
1983	no data	no data	no data	n.a.
1984	no data	5700	no data	n.a.
1985	6275[2]	4985	0.3997	3225 (7)
1986	no data	no data	no data	n.a.
1987	no data	no data	no data	n.a.
1988	no data	no data	no data	n.a.
1989	3908[2]	2771	0.4356	808 (6)
1990	3915[2]	2271	0.4673	1130 (6)
1991	3734[2]	2036	0.4608	1569 (10)
1992	3720[2]	1879	0.5015	1960 (13)
1993	no data	1857	no data	n.a.
1994	3982[3]	1662	no data	n.a.
1995	no data	no data	no data	n.a.
1996	3741[3]	1605	0.4247	3567 (17)
1997	3633[3]	no data	0.4337	3525 (15)
1998	3361[4]	1493	0.3927	2865 (16)
1999	no data	no data	no data	n.a.
2000	2840[4]	1451	0.4443	1908 (17)
2001	no data	1466	no data	n.a.
2002	3221[4]	1487	0.4273	1898 (18)
2003	no data	1432	no data	n.a.
2004	3456[5]	1593	no data	n.a.

1. Pup count is the sum of counts on the Atkins, Chernabura, Clubbing Rocks and Pinnacle Rocks rookeries.

Table A3. The raw data for the eastern Aleutian Islands. Footnote references are the same as for Table A1 except where supplemental information is added below table.

Year	Non-pup count	Pup count[1]	*J/T* metric[6]	Sample size for *J/T* metric # of measurements (# of haul-outs)
1975	19769[2]	no data	no data	n.a.
1976	19743	no data	no data	n.a.
1977	19195	no data	no data	n.a.
1978	no data	no data	no data	n.a.
1979	no data	no data	no data	n.a.
1980	no data	no data	no data	n.a.
1981	no data	no data	no data	n.a.
1982	no data	no data	no data	n.a.
1983	no data	no data	no data	n.a.
1984	no data	no data	no data	n.a.
1985	7505[2]	4778	0.4758	2717 (12)
1986	no data	no data	no data	n.a.
1987	no data	no data	no data	n.a.
1988	no data	no data	no data	n.a.
1989	3032[2]	no data	0.3674	215 (4)
1990	3801[2]	2075	0.5169	563 (3)
1991	4231[2]	2119	0.4687	879 (11)
1992	4839[2]	no data	0.4789	1564 (14)
1993	no data	1879	no data	n.a.
1994	4421[3]	1756	no data	n.a.
1995	no data	no data	no data	n.a.
1996	4716[3]	no data	0.4232	1635 (16)
1997	no data	no data	0.4709	2064 (15)
1998	3847[4]	1474	0.4769	2661 (14)
1999	no data	no data	no data	n.a.
2000	3840[4]	1516	0.4995	1996 (14)
2001	no data	no data	no data	n.a.
2002	3956[4]	1525	0.4400	2234 (19)
2003	no data	no data	no data	n.a.
2004	4707[5]	1744	no data	n.a.

1. Pup count is a sum of pup counts on the Adugak, Akun, Akutan, Bogoslof, and Ugamak rookeries.

Appendix B. Effect of haul-out sites on the *J/T* metric

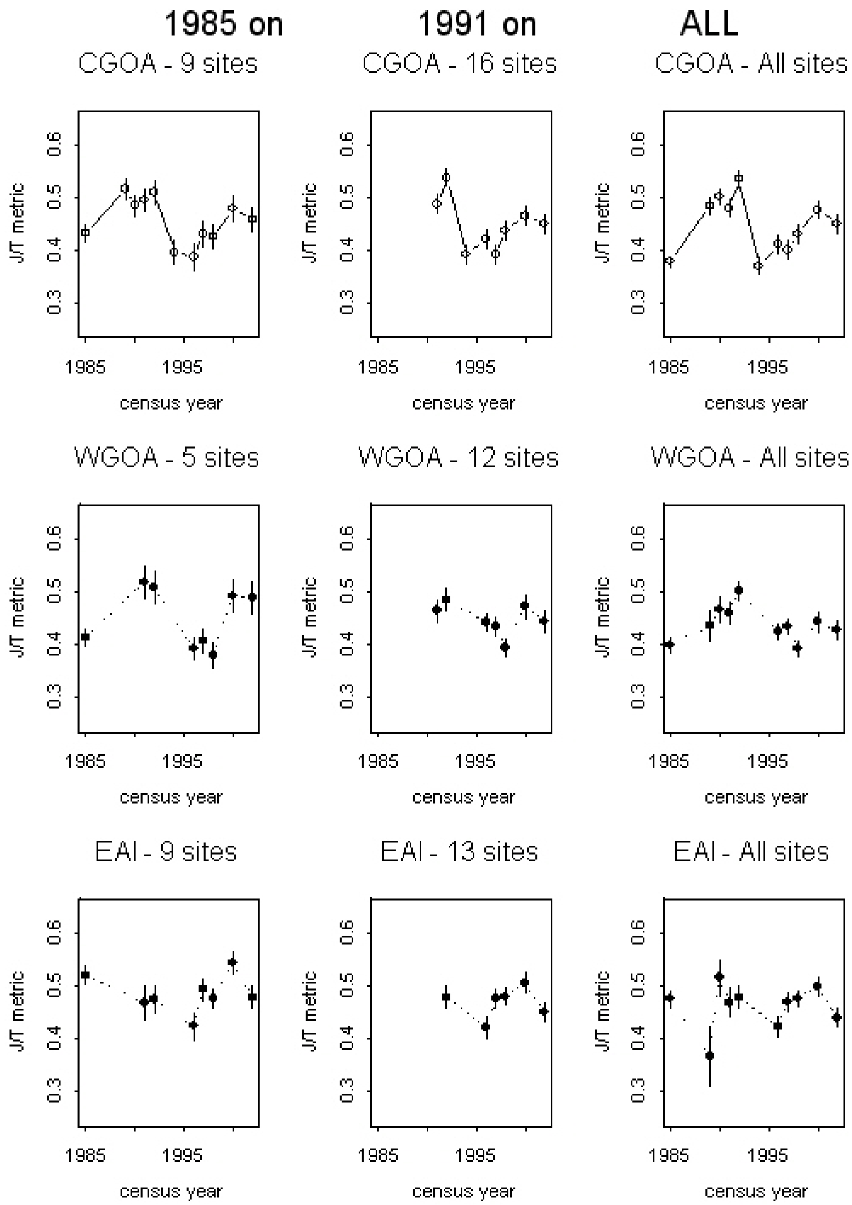

Figure B1. The *J/T* metric using only those haul-outs that were surveyed every year (left panels), using those surveyed regularly in the 1990s (middle panels), and using every photographed haul-out (right panels).

Appendix C. Life-history matrices

The 32 x 32 female-only age-structured life-history matrix for Steller sea lions (**A** in Eq. 3 in the main text) is shown in Table 1 (main text). The matrix is a birth-pulse Leslie matrix where row 1 column *i* is the number of 1-month old pups produced by age *i*+1 females multiplied by the survival rate from age *i* to age *i*+1. Thus when the matrix multiplication, $\vec{N}_{t+1} = \mathbf{A} \times \vec{N}_t$, is performed, the first element of $\vec{N}_{t+1t}$ is the female pup numbers (at 1-month of age) in year *t*+1. Rows *i*, *i* > 1, in the matrix contain the survivorships from age *i* to *i*+1, along the diagonal. The s_i and f_i terms in **A** have been estimated different ways in different published studies based on data from 1975 to1978 on Marmot Island, and these different estimates give rise to the four different life-history matrices are used in this study. Although each matrix is based on a published matrix, there are some slight modifications, namely an increasing juvenile survivorship pattern across all matrices and inclusion of neonate survivorship. The number of female 1-month old pups produced by females of age *i* equals f_i, the late-term pregnancy rate times 0.5 to get female fetuses only, multiplied by s_n, neonate survivorship from age 0 (late-term fetus) to age 1-month when the pup survey occurs. This early pup survivorship was estimated as 0.949 from the average of the fraction of dead pups observed during the 1978 and 1979 pup counts in the CGOA: 492 (dead) to 6720 (live) in 1978 and 526 (dead) to 14763 (live) in 1978. The rest of the s_i and f_i terms which specify the survivorship and fecundity schedule for each matrix are discussed below and are given in Table C1.

A matrix based on Calkins and Pitcher (1982) – CP matrix

For this matrix, the survivorships, s_i, were those estimated originally by Calkins and Pitcher (1982) as presented in their Table 24. These estimates are from the age-distribution observed in the longitudinal sample of Steller sea lions around Marmot Island in the 1970s, which was done by shooting a random sample of animals from the population. Given their smaller size and lack representation near rookeries, individuals younger than 3 years were not equally sampled and were excluded from the analyses. Age was determined by counting the enamel layers in cross-sections of the canine teeth, and pregnancy rates were determined from pregnancies observed in the sampled females. The survivorships in Table C1 are taken from York (1994) Table 1 with the exception of s_0, s_1 and s_2. Juvenile survivorship could not be estimated directly from the data. Instead, York (1994) and Calkins and Pitcher (1982), set juvenile survivorship such that the resulting matrix would be stable (maximum eigenvalue equals 1.0). York (1994) made juvenile survivorship equal for the 1st three years while Calkins and Pitcher (1982) had juvenile survivorship increasing with age. In this analysis, we used Calkins and Pitcher's method, which eliminates a sudden jump from older juvenile survival to young adult survival. Thus s_1 and s_2 increase linearly from s_0 towards s_3, and s_0 is set so that the matrix is stable. Late-term pregnancy rate, f_i, is based on 'percent mature' x 'birth rate' in Table 26 in Calkins and Pitcher (1982) x 0.5 pup sex ratio. 'birth rate' is not precisely birth rate, however, rather it is late-term pregnancy rate. The f_i given in Table C1 are from York (1994), Table 1. Note that the age or *i* column in both York (1994) and Calkins and Pitcher (1982) is confusing. Early maturing females first become mature at age 3 but give birth at age 4, so f_i is 0 for age 0-3.

Winship and Trites (2006) used a very generic model of Steller sea lions based on the Calkins and Pitcher survivorship and fecundity schedules. The matrix (Table C1) has high adult survivorship, lower age 1-3 survivorship, and a uniform late-term pregnancy rate after age 5. For this study, we changed juvenile survivorship so that juvenile survivorship increased linearly from s_0 to s_4 as for the other matrices. If this is not done, the time-varying model can have the biologically odd behavior of high juvenile survivorship (age 1-3) followed by a sudden step-drop to a much lower survivorship at age 4. No animals are allowed to live beyond age 20 in this model, thus the model has fecundity senescence of a sort since no animals give birth after age 20.

Matrix based on York (1994)'s re-analysis of survivorship rates – Y matrix

The Calkins and Pitcher (1982) survivorships result in an equilibrium age-distribution that does not precisely fit the observed age-distribution. York (1994) re-estimated the Calkins and Pitcher (1982) survivorships using a Weibull hazard model which is a standard model for survivorship. The re-estimated survivorships result in an age-distribution that closely matches the sampled cumulative age-distribution. Table C1 gives the re-estimated survivorship schedule.

There are two differences between the matrix used in this paper and the matrix published in York (1994) in Table 1 in that paper. York (1994) made juvenile survivorship equal for the 1st three years. Here, we used Calkins and Pitcher's method as above and allowed juvenile survivorship to increase with age. Thus s_1 and s_2 were set to increase linearly from s_0 towards s_3, and s_0 adjusted so that the matrix is stable. The second difference is in the f_i terms. In the matrix described in York (1994), females erroneously give birth the year that they become pregnant, whereas females give birth in the year after becoming pregnant. Thus the fecundities should be shifted forward by one year. This error is corrected in the f_i values given in Appendix A. This same error appears in the matrix given in Holmes and York (2003). This error does not change the conclusions of either paper, although it does change slightly the estimated natality rate in Holmes and York (2003).

Cited Literature

Calkins, D. G., and K. W. Pitcher. 1982. Population assessment, ecology and trophic relationships of Steller sea lions in the Gulf of Alaska. Final Report 17, U.S. Department of Commerce, Washington, D. C.

Holmes, E. E., and A. E. York. 2003. Using age structure to detect impacts on threatened populations: a case study using Steller sea lions. Conservation Biology **17**:1794-1806.

Winship, A. J., and A. W. Trites. 2006. Risk of extripation of Steller sea lions in the Gulf of Alaska and Aleutian Islands: a population viability analysis based on alternative hypotheses for why sea lions declined in Western Alaska. Marine Mammal Science **23**:124-155.

York, A. E. 1994. The population dynamics of northern sea lions, 1975–1985. Marine Mammal Science **10**:38–51.

Table C1. Fecundity and survivorships terms used in the four life-history matrices. Matrix codes refer to matrices based on different papers: WT (Winship and Trites 2006), CP (Calkins and Pitcher 1982), Y (York 1994), and HFYS (this paper). In all matrices, s_n = 0.949.

i	f_i	f_i	f_i	f_i	s_i	s_i	s_i	s_i
age	WT	CP	Y	HFYS	WT	CP	Y	HFYS
0*	0	0	0	0	0.8001[3]	0.7420[3]	0.7680[3]	0.7845[3]
1	0	0	0	0	0.8334[3]	0.7840[3]	0.8221[3]	0.8331[3]
2	0	0	0	0	0.8667[3]	0.8260[3]	0.8761[3]	0.8316[3]
3	0	0	0	0	0.9	0.8680[1]	0.9302[1]	0.9302[1]
4	0	0.1008[1]	0.1008[1]	0.0480[2]	0.9	0.8790	0.9092	0.9092
5	0.315	0.17955	0.17955	0.1695	0.9	0.8880	0.8951	0.8951
6	0.315	0.26145	0.26145	0.2215	0.9	0.8930	0.8839	0.8839
7	0.315	0.315	0.315	0.27950	0.9	0.8980	0.8746	0.8746
8	0.315	0.315	0.315	0.3285	0.9	0.8740	0.8665	0.8665
9	0.315	0.315	0.315	0.3285	0.9	0.8990	0.8593	0.8593
10	0.315	0.315	0.315	0.3285	0.9	0.8930	0.8527	0.8527
11	0.315	0.315	0.315	0.3885	0.9	0.8960	0.8468	0.8468
12	0.315	0.315	0.315	0.3885	0.9	0.8950	0.8412	0.8412
13	0.315	0.315	0.315	0.3885	0.9	0.8950	0.8360	0.8360
14	0.315	0.315	0.315	0.3885	0.9	0.8950	0.8312	0.8312
15	0.315	0.315	0.315	0.3885	0.9	0.8950	0.8266	0.8266
16	0.315	0.315	0.315	0.3885	0.9	0.8950	0.8223	0.8223

17	0.315	0.315	0.315	0.2570	0.9	0.8950	0.8182	0.8182
18	0.315	0.315	0.315	0.2570	0.9	0.8950	0.8142	0.8142
19	0.315	0.315	0.315	0.2570	0.9	0.8950	0.8105	0.8105
20	0.315	0.315	0.315	0.2570	0.9	0.8950	0.8069	0.8069
21	0.315	0.315	0.315	0.2570	0	0.8950	0.8034	0.8034
22	0	0.315	0.315	0	0	0.8950	0.8001	0.8001
23	0	0.315	0.315	0	0	0.8950	0.7968	0.7968
24	0	0.315	0.315	0	0	0.8950	0.7937	0.7937
25	0	0.315	0.315	0	0	0.8950	0.7907	0.7907
26	0	0.315	0.315	0	0	0.8950	0.7878	0.7878
27	0	0.315	0.315	0	0	0.8950	0.7850	0.7850
28	0	0.315	0.315	0	0	0.8950	0.7822	0.7822
29	0	0.315	0.315	0	0	0.8950	0.7795	0.7795
30	0	0.315	0.315	0	0	0.8950	0.7769	0.7769
31	0	0.315	0.315	0	0	0	0	0

f_i is the fraction of age i females with late-term pregnancies x 0.5 to get female fetuses only (note age i females mate and become impregnated at age i-1). s_i is the survivorship from age i to i+1.

* age 0 denotes 1-month of age which is the age of pups when the survey occurs.

1. Table 1 from York (1994). Note that in Table 1 (York 1994) the age ‘To’ column represents the numbering for f_i, whereas the age ‘From’ column represents the numbering for s_i.
2. Re-estimated in this paper from the original 1970s data. See notes above.

3. s_1 and s_2 increase linearly from s_0 towards s_3, and s_0 is set so that the dominant eigenvalue of the matrix is equal to 1 (meaning a stable population).

Appendix D. Parameter estimates and AIC_c values for model fits

Table D1. Maximum-likelihood estimates of the historical survivorship and birth rate relative to pre-decline levels. The number of free parameters, K, is the number of scaling factors, 3, times the number of time periods, 3 to 4, plus 3 constants, p_1, p_2, p_3, and the 3 variances in the likelihood function. $p_{j,k}$ is the scaling factor for juvenile survivorship in time period k. Juvenile survivorship in time period k is (pre-decline juvenile survivorship) x $p_{j,k}$. $p_{a,k}$ is the scaling factor for adult survivorship in time period k. $p_{f,k}$ is the scaling factor for birth rate in time period k. For all models, the first time period starts in 1983, and the second starts in 1988. The third and fourth (if present) start in the first and second years in column 1, respectively. The Leslie matrices are described in Appendix C.

Time periods	Leslie matrix	ΔAIC_c	K	$p_{j,1}$	$p_{j,2}$	$p_{j,3}$	$p_{j,4}$	$p_{f,1}$	$p_{f,2}$	$p_{f,3}$	$p_{f,4}$	$p_{a,1}$	$p_{a,2}$	$p_{a,3}$	$p_{a,4}$
1997	HFYS	5.454	15	0.436	0.877	1.241	-	0.908	0.841	0.813	-	0.879	0.921	0.963	-
1997	Y	7.884	15	0.421	0.882	1.267	-	0.891	0.846	0.809	-	0.89	0.913	0.957	-
1997	CP	15.133	15	0.443	0.93	1.311	-	0.924	0.873	0.83	-	0.872	0.892	0.952	-
1997	WT	4.9	15	0.506	0.928	1.25	-	0.931	0.86	0.813	-	0.863	0.902	0.965	-
1998	HFYS	7.148	15	0.43	0.911	1.241	-	0.903	0.839	0.787	-	0.881	0.918	0.981	-
1998	Y	10.631	15	0.41	0.911	1.267	-	0.885	0.844	0.81	-	0.893	0.91	0.971	-

1998	CP	17.332	15	0.442	0.998	1.311	-	0.929	0.902	0.84	-	0.869	0.882	0.963	-
1998	WT6	10.993	15	0.504	0.952	1.25	-	0.934	0.869	0.844	-	0.863	0.899	0.971	-
1999	HFYS	12.193	15	0.39	0.901	1.241	-	0.897	0.829	0.813	-	0.885	0.925	0.996	-
1999	Y	17.131	15	0.454	0.955	1.267	-	0.899	0.871	0.872	-	0.886	0.897	0.976	-
1999	CP	22.312	15	0.393	0.991	1.311	-	0.913	0.872	0.879	-	0.878	0.888	0.974	-
1999	WT	17.42	15	0.487	0.945	1.25	-	0.925	0.844	0.865	-	0.866	0.905	0.988	-
1992;1997	HFYS	0	18	0.42	0.734	0.565	0.935	0.869	0.762	0.703	0.641	0.899	0.928	1.002	1.068
1992;1997	Y	3.46	18	0.465	0.787	0.603	0.967	0.882	0.805	0.701	0.613	0.894	0.916	0.988	1.053
1992;1997	CP	6.385	18	0.481	0.818	0.621	0.998	0.903	0.827	0.725	0.628	0.882	0.889	0.965	1.029
1992;1997	WT	6.197	18	0.453	0.731	0.592	0.894	0.887	0.755	0.67	0.585	0.884	0.921	0.989	1.077
1993;1997	HFYS	7.341	18	0.42	0.739	0.591	0.986	0.871	0.754	0.724	0.657	0.898	0.934	1	1.053
1993;1997	Y	10.365	18	0.493	0.827	0.666	1.054	0.89	0.82	0.732	0.645	0.889	0.908	0.978	1.029
1993;1997	CP	14.262	18	0.506	0.85	0.675	1.08	0.91	0.834	0.754	0.657	0.877	0.887	0.961	1.013
1993;1997	WT	9.436	18	0.491	0.794	0.682	0.998	0.905	0.783	0.707	0.621	0.876	0.915	0.976	1.045
1992;1998	HFYS	4.161	18	0.42	0.74	0.622	0.974	0.871	0.761	0.7	0.646	0.899	0.929	0.998	1.075

1992;1998	Y	8.877	18	0.451	0.783	0.635	0.982	0.874	0.784	0.684	0.615	0.899	0.922	0.986	1.069
1992;1998	CP	9.504	18	0.428	0.772	0.611	0.968	0.882	0.78	0.69	0.608	0.893	0.901	0.969	1.056
1992;1998	WT	17.248	18	0.552	0.778	0.798	1.104	0.909	0.792	0.719	0.67	0.874	0.902	0.958	1.031
1993;1998	HFYS	10.82	18	0.395	0.712	0.627	0.966	0.864	0.738	0.708	0.647	0.902	0.941	1.006	1.075
1993;1998	Y	16.075	18	0.523	0.868	0.823	1.191	0.897	0.835	0.757	0.706	0.885	0.898	0.951	1.005
1993;1998	CP	17.738	18	0.479	0.828	0.716	1.085	0.896	0.801	0.727	0.649	0.885	0.893	0.959	1.03
1993;1998	WT	17.327	18	0.543	0.829	0.869	1.164	0.92	0.815	0.747	0.697	0.869	0.902	0.952	1.011
1992;1999	HFYS	12.072	18	0.433	0.731	0.678	1.034	0.868	0.757	0.694	0.668	0.898	0.927	0.998	1.075
1992;1999	Y	17.105	18	0.47	0.779	0.684	1.013	0.88	0.794	0.679	0.628	0.895	0.918	0.99	1.075
1992;1999	CP	16.272	18	0.378	0.695	0.578	0.897	0.871	0.753	0.653	0.593	0.9	0.911	0.987	1.081
1992;1999	WT	22.803	18	0.594	0.796	0.935	1.25	0.923	0.825	0.776	0.748	0.868	0.888	0.938	1.005
1993;1999	HFYS	15.595	18	0.409	0.705	0.691	1.013	0.865	0.738	0.703	0.663	0.901	0.939	1.007	1.075
1993;1999	Y	20.396	18	0.55	0.867	0.937	1.266	0.909	0.86	0.792	0.752	0.879	0.89	0.939	0.992
1993;1999	CP	22.458	18	0.597	0.916	0.964	1.311	0.943	0.904	0.827	0.778	0.862	0.866	0.927	0.983
1993;1999	WT	21.272	18	0.574	0.828	0.964	1.25	0.93	0.838	0.786	0.746	0.865	0.894	0.942	1

Table D2. Maximum-likelihood estimates of the constants and variances for each model. See text for explanation of the constants. p_1 translates to the expected average number (x 1000) of pre-decline female pups in the CGOA. The value, p_2, from column 4 is the scaling factor that translates the nonpup trend count into the total (unobserved) number of nonpup females in the population: $(1/p_2)$ x nonpup trend count = total number (unobserved) of nonpup females. p_3 is the scaling factor for the juvenile-fraction metric (see text).

Time periods	Leslie matrix	p_1 (÷1000)	p_2	p_3	σ^2 nonpup (x1000)	σ^2 pup (x1000)	σ^2 *J/T* (x1000)
1997	HFYS	9.52	0.458	0.359	3.097	0.914	2.761
1997	Y	9.50	0.478	0.368	3.121	0.892	3.555
1997	CP	9.52	0.498	0.379	3.662	1.183	3.68
1997	WT	9.53	0.446	0.37	3.659	0.794	2.521
1998	HFYS	9.53	0.456	0.359	4.362	0.811	2.392
1998	Y	9.51	0.478	0.369	4.744	0.749	3.254
1998	CP	9.52	0.5	0.405	5.575	0.955	3.431

1998	WT	9.50	0.452	0.377	5.66	0.873	2.227
1999	HFYS	9.51	0.462	0.347	5.497	0.8	2.81
1999	Y	9.50	0.482	0.396	6.719	0.847	3.15
1999	CP	9.51	0.502	0.387	7.452	0.891	4.023
1999	WT	9.51	0.452	0.364	7.683	0.908	2.409
1992;1997	HFYS	9.52	0.458	0.229	2.403	0.934	0.527
1992;1997	Y1994	9.52	0.472	0.253	2.426	1.195	0.501
1992;1997	CP	9.53	0.496	0.254	2.742	1.312	0.483
1992;1997	WT	9.52	0.45	0.22	2.762	1.148	0.571
1993;1997	HFYS	9.53	0.456	0.241	2.538	0.917	0.975
1993;1997	Y	9.53	0.47	0.287	2.534	1.178	0.901
1993;1997	CP	9.54	0.494	0.284	2.956	1.257	0.946
1993;1997	WT	9.53	0.446	0.259	2.77	0.992	0.937
1992;1998	HFYS	9.51	0.458	0.233	3.158	0.883	0.576
1992;1998	Y	9.52	0.474	0.246	3.845	1.106	0.49

1992;1998	CP	9.52	0.498	0.224	4.279	1.062	0.475
1992;1998	WT	9.53	0.444	0.282	3.175	1.002	1.56
1993;1998	HFYS	9.52	0.458	0.227	3.132	0.912	1.019
1993;1998	Y	9.53	0.468	0.331	3.359	0.938	1.425
1993;1998	CP	9.53	0.494	0.269	4.164	1.088	1.001
1993;1998	WT	9.54	0.444	0.31	3.051	0.971	1.729
1992;1999	HFYS	9.54	0.456	0.242	3.219	0.935	1.048
1992;1999	Y	9.52	0.472	0.255	3.489	1.527	0.737
1992;1999	CP	9.52	0.5	0.194	3.712	1.418	0.702
1992;1999	WT	9.53	0.444	0.328	3.125	0.949	2.852
1993;1999	HFYS	9.53	0.456	0.237	2.813	1.026	1.543
1993;1999	Y	9.52	0.47	0.364	2.976	0.999	2.287
1993;1999	CP	9.50	0.494	0.377	3.006	1.215	2.074
1993;1999	WT	9.53	0.444	0.338	2.849	0.972	2.724

Appendix E. Summary of studies with estimates of percent time animals are resting on land

Table E1. Summary of studies which report the proportion of time onshore for Steller sea lions. Some studies do not adjust for the tendency of Steller sea lions to forage at night and haul-out on land during the day. In this case, the proportion of time onshore is an underestimate of daytime sightability. All studies are from the Gulf of Alaska except Higgins et al. (1988).

Reference	Type of animal	Proportion of time onshore	Year, Location, Season, Method
Brandon (2000, Table 3.2)	Females nursing pups on rookery	63%[1]	1993, Chirikof Is. (CGOA), June/July Satellite tracking
Call et al. (2007), K. Call, pers. comm..	Juveniles age 11-25 months	43%[2]	CGOA, June/July Satellite tracking
Higgins et al. (1988, Figure 2)	Females nursing 8-14 day old pups on rookery Females nursing 15-21 day old pups on rookery Females nursing 35-47 day old pups on rookery	60%[2] 40%[2] 30%[2]	1983, Ana Nuevo Is., CA, June/July Observation of focal animals
Loughlin et al. (2003, Table 1)	Juveniles age 11-12 mos. (3 animals)	50%[2]	1994-2000, GOA & Aleutians, May/June Satellite tracking
Maniscalco et al. (2006)	Adult females on rookery: pups < ~60 days old Adult females on rookery: pups > ~60 days old	59%[1] 36%[1]	June 1-August 18. 2001-2004, CGOA August 18 – Nov 1, 2002-2004, CGOA Observation of focal animals on rookery

Merrick and Loughlin (1997)	Females nursing pups on rookery (7 animals) Females nursing yearling (2 animals) and females with no pup (3 animals)	48.5%[1] 10.1%[1]	1988-1993, GOA & Aleutians, June/July 1988-1993, GOA&Aleutians, Nov-March Satellite tracking
Milette and Trites (2003, Table 2 and Figure 3) Milette (1999, Table 3.2)	Females nursing 15-day old pups on rookery Females nursing 47-day old pups on rookery	66%[1] 40%[1]	1994/1995, Sugarloaf Is. (CGOA), May-Aug Video analysis of marked female attendance
Trites and Porter (2002, Table 1)	Females nursing yearlings Yearlings (19-22 mos)	22%[1] 15%[2] 40%[2]	1996, Forrester Is. (EGOA), January-April Satellite tracking

1. No correction for daylight versus night attendance patterns.
2. Corrected for daylight versus night attendance pattern

REFERENCES

Brandon, E. A. A. 2000. Maternal investment in Steller sea lions in Alaska. Ph.D. thesis. Texas A&M University, Galveston.

Call, K. A., B. S. Fadely, A. Greig, and M. J. Rehberg. 2007. At-sea and on-shore cycles of juvenile Steller sea lions (*Eumetopias jubatus*) derived from satellite dive recorders: A comparison between declining and increasing populations. Deep-Sea Research **in press**.

Higgins, L. V., D. P. Costa, A. C. Huntley, and B. J. L. Boleuf. 1988. Behavioral and physiological measurements of maternal investment in the Steller se lion, *Eumetopias jubatus*. Marine Mammal Science **4**:44-58.

Loughlin, T. R., J. T. Sterling, R. L. Merrick, J. L. Sease, and A. E. York. 2003. Diving behavior of immature Steller sea lions (*Eumetopias jubatus*). Fishery Bulletin **101**:566-582.

Maniscalco, J. M., P. Parker, and S. Atkinson. 2006. Interseasonal and interannual measures of maternal care among individual Steller sea lions (*Eumetopias jubatus*). Journal of Mammalogy **87**:304-311.

Merrick, R. L., and T. Loughlin. 1997. Foraging behavior of adult female and young-of-year Steller sea lions in Alaskan waters. Canadian Journal of Zoology **75**:776-786.

Milette, L. L. 1999. Behaviour of lactating Steller sea lions (*Eumetopias jubatus*) during the breeding season: a comparison between a declining and stable population in Alaska. M.S. thesis. University of British Columbia.

Milette, L. L., and A. W. Trites. 2003. Maternal attendance patterns of Steller sea lions (*Eumetopias jubatus*) from stable and declining populations in Alaska. Canadian Journal of Zoology **81**:340–348.

Trites, A. W., and B. T. Porter. 2002. Attendance patterns of Steller sea lions (*Eumetopias jubatus*) and their young during winter. Journal of Zoology **256**:547-556.