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E. E. Holmes, L. W. Fritz, A. E. York, and K. Sweeney. 2007. Age-structured modeling reveals long-term declines in the natality of western Steller sea lions. *Ecological Applications* 17:2214-2232.

Appendix D. Parameter estimates and AIC_c values for model fits. Table D1 shows scaling parameters and Table D2 shows constants and variances.

Table D1. Maximum-likelihood estimates of the historical survivorship and birth rate relative to pre-decline levels. The models analyze the period 1976 to 2005. Vital rates are allowed to change as follows. The pre-decline period with vital rates fixed at pre-decline estimate is 1976 to 1982. Next come a series of time periods during which the vital rates are allowed to scale independently to a new value for the entire time period. The first time period, t_1 to (t_2-1), is the same across all models: 1983 to 1987. The second time period is varied across models: 1988 to (t_3-1). The third time period also varies across models: t_3 to (t_4-1). If present in the model, the fourth time period is t_4 to (t_5-1). The first column gives the t_1, t_2, t_3, t_4, and t_5 values that define the time periods. The Leslie matrix used in the model is given in the second column (The Leslie matrices are described in Appendix C). The number of free parameters, K in the fourth column, 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. The remaining columns show the scaling factors for the vital rates in each time period. $p_{j,k}$ 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*. The table is provided as a tab delimited text file in the supplement. Back to top

t_1, t_2, t_3, t_4, t_5	Leslie matrix	ΔAIC_c	K	$p_{j,1}$	$p_{j,2}$	$p_{j,3}$	$p_{j,4}$	$p_{f,1}$	$p_{f,2}$	$p_{f,3}$	$p_{f,4}$	$p_{a,1}$	$p_{a,2}$	$p_{a,3}$	$p_{a,4}$
83 88 97 06	HFYS	5.454	15	0.436	0.877	1.241	-	0.908	0.841	0.813	-	0.879	0.921	0.963	-
83 88 97 06	Y	7.884	15	0.421	0.882	1.267	-	0.891	0.846	0.809	-	0.89	0.913	0.957	-
83 88 97 06	CP	15.133	15	0.443	0.93	1.311	-	0.924	0.873	0.83	-	0.872	0.892	0.952	-
83 88 97 06	WT	4.9	15	0.506	0.928	1.25	-	0.931	0.86	0.813	-	0.863	0.902	0.965	-

83 88 98 06	HFYS	7.148	15	0.43	0.911	1.241	-	0.903	0.839	0.787	-	0.881	0.918	0.981	-
83 88 98 06	Y	10.631	15	0.41	0.911	1.267	-	0.885	0.844	0.81	-	0.893	0.91	0.971	-
83 88 98 06	CP	17.332	15	0.442	0.998	1.311	-	0.929	0.902	0.84	-	0.869	0.882	0.963	-
83 88 98 06	WT6	10.993	15	0.504	0.952	1.25	-	0.934	0.869	0.844	-	0.863	0.899	0.971	-
83 88 99 06	HFYS	12.193	15	0.39	0.901	1.241	-	0.897	0.829	0.813	-	0.885	0.925	0.996	-
83 88 99 06	Y	17.131	15	0.454	0.955	1.267	-	0.899	0.871	0.872	-	0.886	0.897	0.976	-
83 88 99 06	CP	22.312	15	0.393	0.991	1.311	-	0.913	0.872	0.879	-	0.878	0.888	0.974	-
83 88 99 06	WT	17.42	15	0.487	0.945	1.25	-	0.925	0.844	0.865	-	0.866	0.905	0.988	-
83 88 92 97 06	**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**
83 88 92 97 06	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
83 88 92 97 06	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
83 88 92 97 06	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
83 88 93 97 06	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
83 88 93 97 06	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
83 88 93 97 06	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
83 88 93 97 06	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
83 88 92 98 06	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
83 88 92 98 06	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
83 88 92 98 06	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
83 88 92 98 06	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
83 88 93 98 06	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
83 88 93 98 06	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
83 88 93 98 06	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
83 88 93 98 06	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
83 88 92 99 06	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
83 88 92 99 06	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
83 88 92 99 06	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
83 88 92 99 06	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

83 88 93 99 06	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
83 88 93 99 06	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
83 88 93 99 06	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
83 88 93 99 06	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. p_1 translates to the expected average number of pre-decline female pups in the CGOA. p_2 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 for a full explanation of the constants. The model fit with lowest ΔAIC_c is shown in bold font.

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t_1, t_2, t_3, t_4, t_5	Leslie matrix	ΔAIC_c	p_1 ÷1000	p_2	p_3	σ^2 nonpup ×1000	σ^2 pup ×1000	σ^2 J/T ×1000
83 88 97 06	HFYS	5.454	10.016	0.436	0.359	3.097	0.914	2.761
83 88 97 06	Y	7.884	10.004	0.453	0.368	3.121	0.892	3.555
83 88 97 06	CP	15.133	10.016	0.474	0.379	3.662	1.183	3.68
83 88 97 06	WT	4.9	10.029	0.424	0.37	3.659	0.794	2.521
83 88 98 06	HFYS	7.148	10.026	0.433	0.359	4.362	0.811	2.392
83 88 98 06	Y	10.631	10.013	0.454	0.369	4.744	0.749	3.254
83 88 98 06	CP	17.332	10.018	0.475	0.405	5.575	0.955	3.431
83 88 98 06	WT	10.993	9.996	0.429	0.377	5.66	0.873	2.227
83 88 99 06	HFYS	12.193	10.007	0.438	0.347	5.497	0.8	2.81
83 88 99 06	Y	17.131	10.000	0.458	0.396	6.719	0.847	3.15
83 88 99 06	CP	22.312	10.008	0.477	0.387	7.452	0.891	4.023

83 88 99 06	WT	17.42	10.010	0.430	0.364	7.683	0.908	2.409
83 88 92 97 06	**HFYS**	**0**	**10.021**	**0.435**	**0.229**	**2.403**	**0.934**	**0.527**
83 88 92 97 06	Y1994	3.46	10.022	0.449	0.253	2.426	1.195	0.501
83 88 92 97 06	CP	6.385	10.026	0.471	0.254	2.742	1.312	0.483
83 88 92 97 06	WT	6.197	10.024	0.427	0.22	2.762	1.148	0.571
83 88 93 97 06	HFYS	7.341	10.028	0.434	0.241	2.538	0.917	0.975
83 88 93 97 06	Y	10.365	10.036	0.447	0.287	2.534	1.178	0.901
83 88 93 97 06	CP	14.262	10.037	0.469	0.284	2.956	1.257	0.946
83 88 93 97 06	WT	9.436	10.035	0.423	0.259	2.77	0.992	0.937
83 88 92 98 06	HFYS	4.161	10.008	0.436	0.233	3.158	0.883	0.576
83 88 92 98 06	Y	8.877	10.018	0.450	0.246	3.845	1.106	0.49
83 88 92 98 06	CP	9.504	10.021	0.473	0.224	4.279	1.062	0.475
83 88 92 98 06	WT	17.248	10.030	0.423	0.282	3.175	1.002	1.56
83 88 93 98 06	HFYS	10.82	10.017	0.436	0.227	3.132	0.912	1.019
83 88 93 98 06	Y	16.075	10.035	0.445	0.331	3.359	0.938	1.425
83 88 93 98 06	CP	17.738	10.033	0.469	0.269	4.164	1.088	1.001
83 88 93 98 06	WT	17.327	10.037	0.421	0.31	3.051	0.971	1.729
83 88 92 99 06	HFYS	12.072	10.038	0.433	0.242	3.219	0.935	1.048
83 88 92 99 06	Y	17.105	10.025	0.448	0.255	3.489	1.527	0.737
83 88 92 99 06	CP	16.272	10.016	0.474	0.194	3.712	1.418	0.702
83 88 92 99 06	WT	22.803	10.027	0.421	0.328	3.125	0.949	2.852
83 88 93 99 06	HFYS	15.595	10.026	0.434	0.237	2.813	1.026	1.543
83 88 93 99 06	Y	20.396	10.023	0.446	0.364	2.976	0.999	2.287
83 88 93 99 06	CP	22.458	10.005	0.469	0.377	3.006	1.215	2.074
83 88 93 99 06	WT	21.272	10.027	0.421	0.338	2.849	0.972	2.724

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