Resource Equivalency Analysis for Loons
New Carissa Spill, February 1999

May 24, 2005

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The New Carissa oil spill killed approximately 128 Loons in February 1999. Resource equivalency analysis (REA) is used to evaluate the direct loss (birds killed) and indirect loss (two generations of lost reproduction) over time. Details on the method used are provided in the report for Marbled Murrelets in the Seabirds section. The scaling and results of restoration projects are provided in the Restoration Results section. Complete citations are provided in a separate References section. All figures are converted to 2004 values (present value, or PV) using a 3% discount rate. The injury results and REA inputs are provided in the tables below.

Injury Results

Table 1
Total Lost Bird-Years (Debit)

Interim Losses	Lost Bird-Years in PV
Direct Injury	**736.85**
1st Generation	445.91
+ 2nd Generation	114.03
= Total Indirect Injury	**559.94**
Total Direct & Indirect Injury:	**1,296.79**

Table 2
Direct Injury by Age Class*

Year	Discount Factor	Bird-Years by Age Class (0-1)	(1-2)	(2-3)	(3-4)	(4-5)	(5-6)	(6-7)	(7-8)	(8-9)	(9-10)
1999	1.16	23.040	15.158	12.430	10.192	8.358	6.853	10.542	8.645	7.089	5.813
2000	1.13	0.000	20.045	13.188	11.342	9.301	7.982	6.545	10.068	8.256	6.770
2001	1.09	0.000	0.000	14.833	10.880	9.357	8.464	7.263	5.956	9.162	7.513
2002	1.06	0.000	0.000	0.000	12.237	8.976	8.515	7.702	6.610	5.420	8.337
2003	1.03	0.000	0.000	0.000	0.000	10.096	8.168	7.749	7.009	6.015	4.932
2004	1.00	0.000	0.000	0.000	0.000	0.000	9.187	7.433	7.051	6.378	5.473
2005	0.97	0.000	0.000	0.000	0.000	0.000	0.000	8.360	6.764	6.417	5.804
2006	0.94	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.608	6.155	5.839
2007	0.92	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.923	5.601
2008	0.89	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.300
2009	0.86	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2010	0.84	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	0.81	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2012	0.79	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2013	0.77	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2014	0.74	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2015	0.72	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total											

Year	Discount Factor	(10-11)	(11-12)	(12-13)	(13-14)	(14-15)	(15-16)	(16-17)	Total Lost Bird-Years	Total Lost Bird-Years in PV
1999	1.16	4.766	3.909	3.205	2.628	2.155	1.767	1.449	128.000	--
2000	1.13	5.551	4.552	3.733	3.061	2.510	2.058	1.688	116.648	131.288
2001	1.09	6.160	5.052	4.142	3.397	2.785	2.284	1.873	99.121	108.312
2002	1.06	6.837	5.606	4.597	3.769	3.091	2.535	2.078	86.310	91.567
2003	1.03	7.587	6.221	5.101	4.183	3.430	2.813	2.306	75.611	77.879
2004	1.00	4.488	6.904	5.661	4.642	3.807	3.122	2.560	66.707	66.707
2005	0.97	4.981	4.084	6.283	5.152	4.225	3.464	2.841	58.374	56.674
2006	0.94	5.282	4.533	3.717	5.717	4.688	3.844	3.152	50.536	47.635
2007	0.92	5.314	4.806	4.125	3.382	5.203	4.266	3.498	43.119	39.460
2008	0.89	5.097	4.836	4.374	3.753	3.078	4.735	3.882	36.055	32.034
2009	0.86	5.733	4.638	4.400	3.980	3.416	2.801	4.308	29.277	25.254
2010	0.84	0.000	5.217	4.221	4.004	3.622	3.108	2.549	22.721	19.029
2011	0.81	0.000	0.000	4.748	3.841	3.644	3.296	2.828	18.357	14.926
2012	0.79	0.000	0.000	0.000	4.320	3.495	3.316	2.999	14.131	11.155
2013	0.77	0.000	0.000	0.000	0.000	3.931	3.181	3.018	10.130	7.764
2014	0.74	0.000	0.000	0.000	0.000	0.000	3.578	2.895	6.472	4.816
2015	0.72	0.000	0.000	0.000	0.000	0.000	0.000	3.256	3.256	2.352
Total									736.823	**736.851**

*Totals are rounded by the computer; hand calculations may not sum to those presented.

Table 3
Indirect Injury*

Year	Discount Factor	Total # Birds-- Reproduction Age	# Reproducing Females	# 1st Gen Fledglings	Bird-Years/ Fledge in PV	1st Gen Lost Bird-Years Total in PV	Total # Birds-- 1st Gen-- Reproduction Age	# Reproducing Females	# 2nd Gen Fledglings	Bird-Years/ Fledge in PV	2nd Gen Lost Bird-Years Total in PV
1999	1.16	51.968	20.787	11.017	3.949	43.503	0.000	0.000	0.000	0.000	0.000
2000	1.13	54.791	21.916	11.616	3.830	44.489	0.000	0.000	0.000	0.000	0.000
2001	1.09	55.587	22.235	11.784	3.715	43.782	0.000	0.000	0.000	0.000	0.000
2002	1.06	56.582	22.633	11.995	3.604	43.229	0.000	0.000	0.000	0.000	0.000
2003	1.03	57.347	22.939	12.158	3.496	42.499	0.000	0.000	0.000	0.000	0.000
2004	1.00	57.520	23.008	12.194	3.391	41.348	0.000	0.000	0.000	0.000	0.000
2005	0.97	58.374	23.350	12.375	3.289	40.703	2.507	1.003	0.531	3.289	1.748
2006	0.94	50.536	20.214	10.714	3.190	34.180	4.924	1.970	1.044	3.190	3.331
2007	0.92	43.119	17.247	9.141	3.095	28.289	7.163	2.865	1.518	3.095	4.699
2008	0.89	36.055	14.422	7.644	3.002	22.945	9.247	3.699	1.960	3.002	5.885
2009	0.86	29.277	11.711	6.207	2.912	18.072	11.181	4.473	2.370	2.912	6.902
2010	0.84	22.721	9.088	4.817	2.824	13.605	12.950	5.180	2.745	2.824	7.754
2011	0.81	18.357	7.343	3.892	2.740	10.662	14.600	5.840	3.095	2.740	8.480
2012	0.79	14.131	5.652	2.996	2.658	7.961	15.724	6.290	3.333	2.658	8.859
2013	0.77	10.130	4.052	2.148	2.578	5.536	16.389	6.555	3.474	2.578	8.956
2014	0.74	6.472	2.589	1.372	2.500	3.431	16.653	6.661	3.530	2.500	8.828
2015	0.72	3.256	1.302	0.690	2.425	1.674	16.566	6.627	3.512	2.425	8.518
2016	0.70	0.000	0.000	0.000	0.000	0.000	15.283	6.113	3.240	2.353	7.623
2017	0.68	0.000	0.000	0.000	0.000	0.000	13.857	5.543	2.938	2.282	6.704
2018	0.66	0.000	0.000	0.000	0.000	0.000	12.341	4.936	2.616	2.214	5.791
2019	0.64	0.000	0.000	0.000	0.000	0.000	10.752	4.301	2.279	2.147	4.894
2020	0.62	0.000	0.000	0.000	0.000	0.000	9.116	3.646	1.933	2.083	4.025
2021	0.61	0.000	0.000	0.000	0.000	0.000	7.469	2.988	1.583	2.020	3.199
2022	0.59	0.000	0.000	0.000	0.000	0.000	5.799	2.320	1.229	1.960	2.409
2023	0.57	0.000	0.000	0.000	0.000	0.000	4.413	1.765	0.936	1.901	1.779
2024	0.55	0.000	0.000	0.000	0.000	0.000	3.279	1.312	0.695	1.844	1.282
2025	0.54	0.000	0.000	0.000	0.000	0.000	2.368	0.947	0.502	1.789	0.898
2026	0.52	0.000	0.000	0.000	0.000	0.000	1.654	0.662	0.351	1.735	0.608
2027	0.51	0.000	0.000	0.000	0.000	0.000	1.117	0.447	0.237	1.683	0.398
2028	0.49	0.000	0.000	0.000	0.000	0.000	0.703	0.281	0.149	1.632	0.243
2029	0.48	0.000	0.000	0.000	0.000	0.000	0.398	0.159	0.084	1.583	0.134
2030	0.46	0.000	0.000	0.000	0.000	0.000	0.189	0.076	0.040	1.536	0.061
2031	0.45	0.000	0.000	0.000	0.000	0.000	0.061	0.024	0.013	1.490	0.019
Total		626.221	250.488	132.759		**445.908**	216.702	86.681			**114.028**

*Totals are rounded by the computer; hand calculations may not sum to those presented.

REA Inputs

Table 4
Injury, Life History & Demographic Parameters

Parameter	REA Value	Reference
Species	Common Loon Pacific Loon Red-Throated Loon	Morgue database
# loons killed (carcasses in hand)	80	Morgue database
# injured (rehabilitated birds)	3	Rehabilitation records
Estimated direct mortality (includes injured birds)	128	Morgue database; rehabilitation records; Ford *et al.* 2001
Confidence in mortality estimate	High	Ford *et al.* 2001
Age distribution	18.0% 0-1 year old 41.4% 1-6 years old 40.6% 6+ years old	OSPR Generic Bird REA 2002
Average life span	17 years	Evers 2004; calculated based on adult survival rate of 91% (Lank 2003)
Age of first breeding	6 years	Evers 2004
Expected years of breeding	11 years	Average lifespan - Age of first breeding
Percentage of adult females that breed	80%	Evers 2004
# eggs/nest	2	McIntyre & Barr 1997; Evers 2004
Nesting success	0.53 fledglings/pair	Evers 2004
Fecundity	0.27 fledglings/individual	Sperduto *et al.* 1999
Nesting density - Northern Maine	2.4 territorial pairs per 1000 acres	Evers 2004
year 0-1 survival	0.74	Evers 2004
year 1-2 survival	0.74	Evers 2004
year 2-3 survival	0.74	Evers 2004
year 3-4 survival	0.825	Interpolation
year 4-5 survival	0.825	Interpolation
year 5-6 survival	0.825	Interpolation
year 6+ survival	0.91	Evers 2004
Threatened or Endangered?	No	
Locally overpopulated?	No	
Additional factors affecting recovery	–	

Source: Research and data were provided by Mike Szumski, Natural Resource Damage Assessment/Spill Response, US Fish & Wildlife Service, US Department of the Interior, 2600 SE 98th Ave., Suite 100, Portland, OR, 97266-1398, August 30, 2004, and finalized on May 5, 2005.

Table 5
Loon Population Information

% of Total Population	Age	Age Distribution of 128 Birds*	Annual Survival Rate
18%	0–1	23.040	0.74
41.4%	1–2	15.158	
	2–3	12.430	
	3–4	10.192	0.825
	4–5	8.358	
	5–6	6.853	
40.6%	6–7	10.542	0.91
	7-8	8.645	
	8-9	7.089	
	9-10	5.813	
	10-11	4.766	
	11-12	3.909	
	12-13	3.205	
	13-14	2.628	
	14-15	2.155	
	15-16	1.767	
	16-17	1.449	
	Total:	128	

*Totals are rounded by the computer; hand calculations may not sum to those presented.