Resource Equivalency Analysis for Cormorants
New Carissa Spill, February 1999

May 24, 2005

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The New Carissa oil spill killed approximately 180 Cormorants 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	Bird-Years in PV
Direct Injury	**589.94**
1st Generation	393.03
+ 2nd Generation	136.84
= Total Indirect Injury	**529.87**
Total Direct & Indirect Injury:	**1,119.81**

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)	Total Lost Bird-Years	Total Lost Bird-Years in PV
1999	1.16	61.425	29.025	21.825	18.225	16.425	12.825	11.025	9.225	180.000	--
2000	1.13	0.000	53.440	26.848	20.188	16.858	15.193	11.863	10.198	154.589	173.991
2001	1.09	0.000	0.000	45.424	22.821	17.160	14.329	12.914	10.084	122.732	134.112
2002	1.06	0.000	0.000	0.000	38.610	19.398	14.586	12.180	10.977	95.751	101.582
2003	1.03	0.000	0.000	0.000	0.000	32.819	16.488	12.398	10.353	72.058	74.220
2004	1.00	0.000	0.000	0.000	0.000	0.000	27.896	14.015	10.538	52.449	52.449
2005	0.97	0.000	0.000	0.000	0.000	0.000	0.000	23.712	11.913	35.624	34.587
2006	0.94	0.000	0.000	0.000	0.000	0.000	0.000	0.000	20.155	20.155	18.998
Total										**553.357**	**589.938**

*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	49.500	19.800	24.750	2.182	54.013	0.000	0.000	0.000	0.000	0.000
2000	1.13	54.113	21.645	27.056	2.117	57.274	0.000	0.000	0.000	0.000	0.000
2001	1.09	54.487	21.795	27.244	2.053	55.941	0.000	0.000	0.000	0.000	0.000
2002	1.06	57.141	22.856	28.570	1.992	56.905	0.000	0.000	0.000	0.000	0.000
2003	1.03	72.058	28.823	36.029	1.932	69.608	6.352	2.541	3.176	1.932	6.136
2004	1.00	52.449	20.980	26.225	1.874	49.146	12.342	4.937	6.171	1.874	11.565
2005	0.97	35.624	14.250	17.812	1.818	32.379	17.483	6.993	8.741	1.818	15.890
2006	0.94	20.155	8.062	10.077	1.763	17.769	22.192	8.877	11.096	1.763	19.566
2007	0.92	0.000	0.000	0.000	0.000	0.000	24.794	9.918	12.397	1.710	21.204
2008	0.89	0.000	0.000	0.000	0.000	0.000	24.180	9.672	12.090	1.659	20.059
2009	0.86	0.000	0.000	0.000	0.000	0.000	21.475	8.590	10.737	1.609	17.280
2010	0.84	0.000	0.000	0.000	0.000	0.000	17.012	6.805	8.506	1.561	13.278
2011	0.81	0.000	0.000	0.000	0.000	0.000	9.634	3.854	4.817	1.514	7.294
2012	0.79	0.000	0.000	0.000	0.000	0.000	4.676	1.870	2.338	1.469	3.434
2013	0.77	0.000	0.000	0.000	0.000	0.000	1.588	0.635	0.794	1.425	1.131
Total		395.526	158.210	197.763		**393.034**	161.729	64.691			**136.836**

*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	Brandt's Double-Crested Pelagic	Field Surveys
# Cormorants killed (carcasses in hand)	94	Morgue database
# Cormorants injured (rehabbed birds)	2	Rehab records
Estimated direct mortality (includes injured birds)	180	Rehab records; Ford *et al.* 2001
Confidence in mortality estimate	High	Ford *et al.* 2001
Age distribution of birds killed (estimate)	34% 0-1 year 16% 1-2 year 12% 2-3 years 10% 3-4 years 9% 4-5 years 7% 5-6 years 6% 6-7 years 5% 7-8 years	OSPR General Bird REA 2002
Average life span	8 years	Calculated based on adult survival rate of 0.85 (Hatch & Weseloh 1999)
Age of first breeding	4 years	Hatch & Weseloh 1999; Wallace & Wallace 1998
Expected years of breeding	4 years	Average lifespan - Age of first breeding
Percentage of adult females that breed	80%	Estimate – No data
# eggs/nest	3	Hatch & Weseloh 1999; Wallace & Wallace 1998; Hobson 1997
Nesting success (% of nests that successfully fledge a chick)	62%; 1.25 fledglings/pair	Hatch & Weseloh 1999; Wallace & Wallace 1998; Hobson 1997; Boekelheide *et al.* 1990a and 1990b
year 0-1 survival	0.48	Hatch & Weseloh 1999; OSPR 2002
year 1-2 survival	0.74	Hatch & Weseloh 1999; OSPR 2002
years 2+ survival	0.85	Hatch & Weseloh 1999; OSPR 2002
Threatened or endangered?	No	–
Locally overpopulated?	No	–
Additional factors affecting recovery	None	–

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, October 21, 2004, and finalized on May 5, 2005.

Table 5
Cormorant Population Information

% of Total Population*	Age	Age Distribution of 180 Birds**	Annual Survival Rate
34%	0–1	61.425	0.48
16%	1–2	29.025	0.74
12%	2–3	21.825	0.85
10%	3–4	18.225	
9%	4–5	16.425	
7%	5–6	12.825	
6%	6–7	11.025	
5%	7-8	9.225	
	Total:	180	

*The figures provided only account for 99% of the population given rounding. The remaining 1% was spread across all age classes, effectively adding 0.125% to each one.
**Totals are rounded by the computer; hand calculations may not sum to those presented.