

**Resource Equivalency Analysis for Sanderling & Other Shorebirds  
New Carissa Spill, February 1999**

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*Prepared by:*

**Kristin E. Skrabis, Ph.D.  
Resource Economist  
Office of Policy Analysis, ms-4426  
US Department of the Interior  
1849 C Street, NW  
Washington, DC 20240  
202-208-4979 (phone)  
202-208-4867 (fax)  
Kristin\_Skrabis@ios.doi.gov**

*Prepared for:*

**Bureau of Land Management  
US Fish & Wildlife Service  
US Department of the Interior**

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**Resource Equivalency Analysis for Sanderling & Other Shorebirds  
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The New Carissa oil spill killed approximately 672 Sanderlings and other shorebirds 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)**

<b>Interim Losses</b>	<b>Lost Bird-Years in PV</b>
<b>Direct Injury</b>	<b>2,153.00</b>
<b>1<sup>st</sup> Generation</b>	2,690.13
<b>+ 2<sup>nd</sup> Generation</b>	2,201.50
<b>= Total Indirect Injury</b>	<b>4,891.63</b>
<b>Total Direct &amp; Indirect Injury:</b>	<b>7,044.63</b>

**Table 2  
Direct Injury by Age Class\***

<b>Year</b>	<b>Factor</b>	<b>Discount Bird-Years by Age Class</b>								<b>Total Lost Bird-Years</b>	<b>Total Lost Bird-Years in PV</b>
		<b>(0-1)</b>	<b>(1-2)</b>	<b>(2-3)</b>	<b>(3-4)</b>	<b>(4-5)</b>	<b>(5-6)</b>	<b>(6-7)</b>	<b>(7-8)</b>		
1999	1.16	268.800	107.520	80.640	60.315	50.062	41.551	34.487	28.625	672.000	--
2000	1.13	0.000	228.480	98.381	73.786	55.188	45.806	38.019	31.556	571.217	642.909
2001	1.09	0.000	0.000	189.638	81.656	61.242	45.806	38.019	31.556	447.918	489.452
2002	1.06	0.000	0.000	0.000	157.400	67.775	50.831	38.019	31.556	345.581	366.626
2003	1.03	0.000	0.000	0.000	0.000	130.642	56.253	42.190	31.556	260.640	268.460
2004	1.00	0.000	0.000	0.000	0.000	0.000	108.433	46.690	35.017	190.140	190.140
2005	0.97	0.000	0.000	0.000	0.000	0.000	0.000	89.999	38.753	128.752	125.002
2006	0.94	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74.699	74.699	70.411
<b>Total</b>										<b>2018.947</b>	<b>2153.001</b>

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

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**Table 3**  
**Indirect Injury\***

Year	Discount Factor	Total # Birds-- Reproduction Age	1st Gen Lost				Total # Birds--				2nd Gen Lost
			# Reproducing Females	# 1st Gen Fledglings	Bird-Years/ Fledge in PV	Bird-Years Total in PV	1st Gen-- Reproduction Age	# Reproducing Females	# 2nd Gen Fledglings	Bird-Years/ Fledge in PV	Bird-Years Total in PV
1999	1.16	295.680	118.272	246.006	1.678	412.859	0.000	0.000	0.000	0.000	0.000
2000	1.13	342.737	137.095	285.157	1.628	464.207	0.000	0.000	0.000	0.000	0.000
2001	1.09	447.918	179.167	372.668	1.579	588.467	68.882	27.553	57.310	1.579	90.495
2002	1.06	345.581	138.232	287.523	1.532	440.397	137.016	54.806	113.997	1.532	174.608
2003	1.03	260.640	104.256	216.853	1.486	322.187	218.070	87.228	181.434	1.486	269.564
2004	1.00	190.140	76.056	158.197	1.441	227.988	261.505	104.602	217.572	1.441	313.558
2005	0.97	128.752	51.501	107.121	1.398	149.749	277.768	111.107	231.103	1.398	323.066
2006	0.94	74.699	29.880	62.150	1.356	84.275	274.842	109.937	228.669	1.356	310.074
2007	0.92	0.000	0.000	0.000	0.000	0.000	235.593	94.237	196.013	1.315	257.819
2008	0.89	0.000	0.000	0.000	0.000	0.000	186.840	74.736	155.451	1.276	198.333
2009	0.86	0.000	0.000	0.000	0.000	0.000	120.962	48.385	100.640	1.238	124.550
2010	0.84	0.000	0.000	0.000	0.000	0.000	74.077	29.631	61.632	1.200	73.987
2011	0.81	0.000	0.000	0.000	0.000	0.000	41.633	16.653	34.639	1.164	40.335
2012	0.79	0.000	0.000	0.000	0.000	0.000	20.073	8.029	16.701	1.130	18.864
2013	0.77	0.000	0.000	0.000	0.000	0.000	6.855	2.742	5.703	1.096	6.248
<b>Total</b>		<b>2,086.147</b>	<b>834.459</b>	<b>1,735.674</b>		<b>2,690.129</b>	<b>1,924.114</b>	<b>769.646</b>			<b>2,201.503</b>

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

**REA Inputs**

**Table 4**  
**Injury, Life History & Demographic Parameters**

<b>Parameter</b>	<b>REA Value</b>	<b>Reference</b>
Species	Sanderling	Field Surveys
# shorebirds killed (carcasses in hand)	4	Morgue database
# injured (observed oiled birds)	668	Field Surveys
Estimated direct mortality (includes injured birds)	672	Field Surveys; Ford <i>et al.</i> 2001
Confidence in mortality estimate	Moderate	Ford <i>et al.</i> 2001
Age Distribution of Birds Killed (estimate)	40% 0-1 year 16% 1-2 years 12% 2-3 years 32% 3+ years	OSPR General Bird REA 2002; Wilson 1994; Cooper 1994
Average life span	8 years	Calculated based on adult survival rate of 83% (MacWhirter <i>et al.</i> 2002)
Age of first breeding	2 years	MacWhirter <i>et al.</i> 2002
Expected years of breeding	6 years	Average lifespan - age of first breeding
Percentage of adult females that breed	80%	Estimate; Senner & McCaffery 1997
# eggs/nest	4	MacWhirter <i>et al.</i> 2002
Nesting success (% of nests that successfully fledge a chick)	52% 2.08 fledglings/pair	Warnock & Gill 1996; Wilson 1994; Cooper 1994; Oring <i>et al.</i> 1997
year 0-1 survival	0.40	Warnock & Gill 1996; Gratto-Trevor 1992
year 1-2 survival	0.70	Estimate
year 2+ survival	0.83	MacWhirter <i>et al.</i> 2002
Threatened or Endangered?	No	
Locally overpopulated?	No	
Additional factors affecting recovery	Stop-over areas critical on migration to breeding grounds	Wilson 1994; Cooper 1994; Warnock & Gill 1996
Midwinter density – US Pacific coast	30-40 birds/km beach	MacWhirter <i>et al.</i> 2002
Spring density - Outer coast beaches in central Oregon and around mouth of Columbia	185 birds/km beach	MacWhirter <i>et al.</i> 2002

**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 12, 2004, and finalized on May 7, 2005.

**Table 5**  
**Sanderling and Other Shorebirds Population Information**

<b>% of Total Population</b>	<b>Age</b>	<b>Age Distribution of 672 Birds*</b>	<b>Annual Survival Rate</b>
40%	0-1	268.800	0.40
16%	1-2	107.520	0.70
12%	2-3	80.640	0.83
32%	3-4	60.315	
	4-5	50.062	
	5-6	41.551	
	6-7	34.487	
	7-8	28.625	
Total:		672	

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