

**Seabird & Shorebird Restoration Credits  
New Carissa Spill, February 1999**

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**Author's Note:** Readers will observe that more than the usual one or two significant digits are presented for the computed values in the attached analysis. This choice is not intended to convey an excessive level of confidence in the calculations. Rather, the decision was made to provide sufficient information to maximize the transparency and reproducibility of the results.

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**Restoration Credit Summary**

As documented in the *Damage Assessment Restoration Plan & Environmental Assessment*, cooperative studies co-funded by the Trustees and the Responsible Parties concluded that the M/V New Carissa oil spill killed 4 to 8 Western Snowy Plovers, a federally threatened species; injured or killed 460 to 809 other shorebirds; and killed 2,465 seabirds and gulls, including 262 Marbled Murrelets, another federally threatened species. Resource equivalency analysis (REA) is used to evaluate the direct loss (birds killed) and indirect loss (two generations of lost reproduction) over time. The Western Snowy Plover, Seabirds, and Other Shorebirds sections of this compendium provide reports on the lost bird-years (debit) due to the oil spill, all of which are compiled in the Injuries Summary section. The proposed restoration projects for the Western Snowy Plover and the Marbled Murrelet are evaluated in their respective reports. To offset the remainder of the lost bird-years, five additional proposed restoration alternatives, the restoration credit method, inputs, and results are evaluated in this report. The final results are summarized below in Table 1. All figures are converted to 2004 values (present value, or PV) using a 3% discount rate. Totals are rounded by the computer; hand calculations may not sum to those presented. Complete citations are provided in a separate References section.

**Table 1  
Summary of Total Restoration Credits in PV**

<b>Restoration Project Options</b>	<b>Restored Bird-Years in PV</b>	
(1) Seabird Proposed Parcel A	Cormorants	16,072.09
	Auks	2,106.61
	<b>Total:</b>	<b>18,178.70</b>
(2) Seabird Proposed Predator Management	Cormorants	29,812.80
	Auks	6,454.29
	Storm-Petrels	651.86
<b>Total:</b>	<b>36,918.95</b>	
(3) Seabird Alternative Parcel B	Cormorants	24,667.16
	Auks	1,011.18
	<b>Total:</b>	<b>25,678.34</b>
(4) Shorebird Proposed Acquisition A	<b>11,448.046</b>	
(5) Shorebird Alternative Property 1	<b>73,986.23</b>	

**Calculating Restoration Credits: Introduction**

The first step in conducting an REA is to identify the lost bird-years from the birds injured and killed by the New Carissa oil spill. Depending on the type of project, the second step, presented here, is to quantitatively characterize the services restored by one unit of the proposed restoration projects. The third step in REA, also provided here, is to identify the credit value of each restoration project in total bird-years that may be used to offset the debit in bird-years. The expected number of protected/restored birds are fixed by the size and quality of the specific project, so the credit in total bird-years needs to be estimated based on the actual project. This is different from typical project scaling that tries to identify the size of a project by dividing the total discounted value of lost services in bird-years by the total discounted value of a project's productivity in bird-years per bird to result in a credit of total birds that need to be restored. The restoration credits for the Western Snowy Plover and Marbled Murrelet are provided in their reports. The following provides the analysis of restoration credits for the remaining seabirds and shorebirds.

**Calculating Restoration Credits: Seabirds**

Table 2 provides an overview of the two proposed and one alternative seabird restoration project options which protect and restore nests for the remaining seabirds.

**Table 2  
Restoration Project Options: Seabirds**

<b>Restoration Project Options</b>	<b>Benefits to Seabirds</b>				
(1) Proposed Parcel A	Acquisition and management is estimated to protect 230 additional nests for cormorants (Pelagic) and 25 for auks (Pigeon Guillemot), resulting in increased bird-years produced per nest. The acquisition process starts in 2005-2006 and restored bird-years start from 2006 in perpetuity.				
(2) Proposed Predator Management	Predator (red fox) management starting by 2006 would protect and increase the number of nests over a 4-year period. The number of nests in 2006 reflects the most recent count of nests, the benefits of which occur in 2006. The number of nests shown in 2007 through 2009 show the increasing number of nests expected from predator management. The result is increased bird-years produced per nest that would continue at the 2009 level in perpetuity with ongoing management.				
	<b>Species</b>	<b># Nests Protected/Restored</b>			
		<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
	Cormorants	93	223	353	485
	Auks	20	39	63	87
Storm-Petrels	0	5	10	16	
(3) Seabird Alternative Parcel B	Acquisition and management is estimated to protect 353 additional nests for cormorants (Brandt's & Pelagic) and 12 nests for auks (Tufted Puffin & Pigeon Guillemot), resulting in increased bird-years produced per nest. Acquisition process starts in 2005 and bird-years restored start from 2006 in perpetuity.				

Source: Lowe, Roy W., D. Pitkin 2004. Estimated bird use for potential seabird and shorebird restoration projects for the *M/V New Carissa* NRDA. Memo to Trustees, October 7, 2004.

The following questions are used to estimate the restoration credits for the seabird projects:

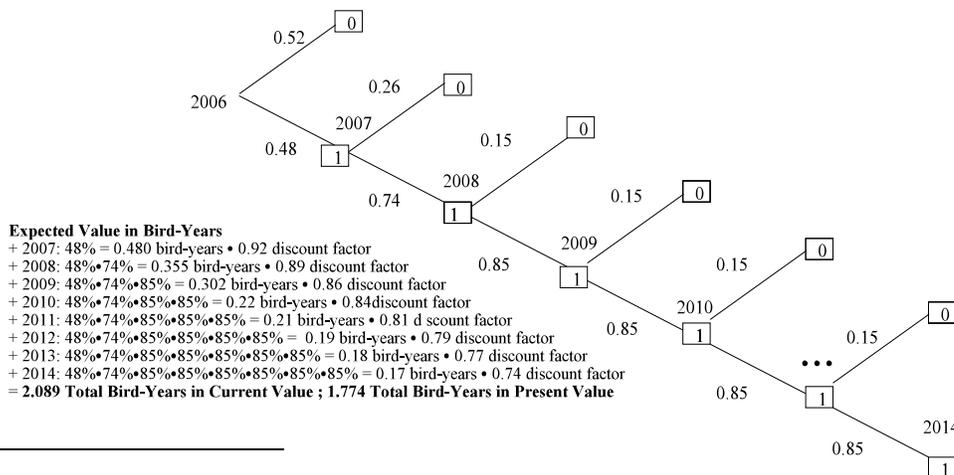
- How many birds may be expected annually by providing one additional nest?
- What kind of bird(s) may be expected to use the nest?
- How many bird-years may be expected per bird restored by a nest?
- What is the credit value in bird-years of the entire project?

As illustrated for cormorants in Table 3, the restoration credits are estimated on an annual basis. Because the acquisition and management projects are in existing areas of bird use, the bird-years are assumed to occur immediately in 2006. As such, the total number of protected nests are multiplied by the expected number of fledglings per nest by species and the bird-years per fledgling restored in present value (base year is 2004). The bird-years per fledgling are accrued over the expected lifespan of the birds by species, as illustrated in Figure 1 for the cormorant. The resulting total bird-years are only for 2006. The nests are assumed to be protected in perpetuity, as shown in Table 4.

**Table 3**  
**Calculating Restoration Credits for Seabird Projects in 2006**  
**Project (1): Proposed Parcel A for Cormorants**

230	Total nests managed for cormorants in 2006 (see Table 2)
x 1.25	Cormorant fledglings per nest in 2006 (see Cormorant report in Seabird Section of Compendium)
x 1.77	Bird-years per fledgling restored in PV <sup>1</sup> (see Figure 2)
-----	
= 510.15	Restored bird-years in PV for 2006

**Figure 1**  
**Expected Value of Having One Cormorant Survive Through Its 8-Year Lifespan Fledged in 2006 and Dies in 2014**



<sup>1</sup> Bird-years/fledgling in PV is slightly different in the credit side (e.g., 1.774 for cormorants in 2006) than shown in the debit sections of this Compendium (e.g., 1.763 for cormorants indirect injury in 2006). The same inputs were used, but the debit side has slightly more rounding error to facilitate the modeling over the restricted number of future generations given the “but for” context of NRDAR.

**Table 4**  
**Total Restored Bird-Years in PV**  
**Project (1): Proposed Parcel A for Cormorants**

<b>Year</b>	<b>Total # Nests</b>	<b># Fledglings/ Nest</b>	<b>Bird-Years/ Fledgling in PV</b>	<b>Total Restored Bird-Years in PV</b>
2006	230	1.25	1.774	510.149
2007 in perpetuity	230	1.25	54.128*	15,561.939
				<b>16,072.088</b>

\*Perpetuity calculation:  $1 \div [1.03^{(2007-2004)} \times 0.03] \times 1.774$  bird-years = 54.128 bird-years

Table 5 shows restored bird-years for auks over time for Project (1). The total credit value for Project (1) is 18,178.7 bird-years (16,072.088 for cormorants + 2106.615 for auks).

**Table 5**  
**Total Restored Bird-Years in PV**  
**Project (1): Proposed Parcel A for Auks**

<b>Year</b>	<b>Total # Nests</b>	<b># Fledglings/ Nest</b>	<b>Bird-Years/ Fledgling in PV</b>	<b>Total Restored Bird-Years in PV</b>
2006	25	0.85	3.147	66.867
2007 in perpetuity	25	0.85	95.988	2,039.748
				<b>2,106.615</b>

\*Perpetuity calculation:  $1 \div [1.03^{(2007-2004)} \times 0.03] \times 3.147$  bird-years = 95.988 bird-years

Tables 6 through 10 show the final results for seabird restoration project options (2) and (3), using the same basic method as described above. Unlike Projects (1) and (3), Project (2) has an increasing number of nests expected from predator management that becomes stable after four years, as shown in Tables 6 through 8. The present value of bird-years from fledglings declines by the 3% discount rate. The perpetuity calculation accounts for bird-years expected for 2010 and beyond.

The total credit value for Project (2) is 36,918.95 bird-years (29,812.80 for cormorants + 6,454.29 for auks + 651.86 storm-petrels). The total credit value for Project (3) is 25,678.34 bird-years (24,667.16 for cormorants + 1,011.18 for auks). A summary of the total value of restoration credits for seabirds is provided in Table 11.

**Table 6**  
**Total Restored Bird-Years in PV**  
**Project (2): Proposed Predator Management for Cormorants**

<b>Year</b>	<b>Total # Nests</b>	<b># Fledglings/ Nest</b>	<b>Bird-Years/ Fledgling in PV</b>	<b>Total Restored Bird-Years in PV</b>
2006	93	1.25	1.774	206.277
2007	223	1.25	1.721*	479.784
2008	353	1.25	1.670	736.694
2009	485	1.25	1.619	981.806
2010 in perpetuity	485	1.25	45.209**	27,408.240
				<b>29,812.801</b>

\* The bird-years per fledgling in present value for 2007 is approximately 97% of 2006, reflecting the 3% discount rate, and so on.

\*\*Perpetuity calculation:  $1 \div [1.03^{(2010-2004)} \times 0.03] \times 1.619$  bird-years = 45.209 bird-years

**Table 7**  
**Total Restored Bird-Years in PV**  
**Project (2): Proposed Predator Management for Auks**

<b>Year</b>	<b>Total # Nests</b>	<b># Fledglings/ Nest</b>	<b>Bird-Years/ Fledgling in PV</b>	<b>Total Restored Bird-Years in PV</b>
2006	20	0.85	3.147	53.493
2007	39	0.85	3.052	101.183
2008	63	0.85	2.961	158.545
2009	87	0.85	2.872	212.375
2010 in perpetuity	87	0.85	80.172*	5,928.698
				<b>6,454.294</b>

\*Perpetuity calculation:  $1 \div [1.03^{(2010-2004)} \times 0.03] \times 2.872$  bird-years = 80.172 bird-years

**Table 8**  
**Total Restored Bird-Years in PV**  
**Project (2): Proposed Predator Management for Storm-Petrels**

<b>Year</b>	<b>Total # Nests</b>	<b># Fledglings/ Nest</b>	<b>Bird-Years/ Fledgling in PV</b>	<b>Total Restored Bird-Years in PV</b>
2006	0	0.60	2.489	0.000
2007	5	0.60	2.414	7.243
2008	10	0.60	2.342	14.051
2009	16	0.60	2.272	21.807
2010 in perpetuity	16	0.60	63.412*	608.759
				<b>651.859</b>

\*Perpetuity calculation:  $1 \div [1.03^{(2010-2004)} \times 0.03] \times 2.272$  bird-years = 63.412 bird-years

**Table 9**  
**Total Restored Bird-Years in PV**  
**Project (3): Alternative Parcel B for Cormorants**

<b>Year</b>	<b>Total # Nests</b>	<b># Fledglings/ Nest</b>	<b>Bird-Years/ Fledgling in PV</b>	<b>Total Restored Bird-Years in PV</b>
2006	353	1.25	1.774	782.967
2007 in perpetuity	353	1.25	54.128*	23,884.193
				<b>24,667.161</b>

\*Perpetuity calculation:  $1 \div [1.03^{(2007-2004)} \times 0.03] \times 1.774$  bird-years = 54.128 bird-years

**Table 10**  
**Total Restored Bird-Years in PV**  
**Project (3): Alternative Parcel B for Auks**

<b>Year</b>	<b>Total # Nests</b>	<b># Fledglings/ Nest</b>	<b>Bird-Years/ Fledgling in PV</b>	<b>Total Restored Bird-Years in PV</b>
2006	12	0.85	3.147	32.096
2007 in perpetuity	12	0.85	95.988*	979.079
				<b>1,011.175</b>

\*Perpetuity calculation:  $1 \div [1.03^{(2007-2004)} \times 0.03] \times 3.147$  bird-years = 95.988 bird-years

**Table 11**  
**Summary of Total Restoration Credits in PV: Seabirds**

<b>Restoration Project Options</b>	<b>Restored Bird-Years in PV</b>	
(1) Seabird Proposed Parcel A	Cormorants	16,072.09
	Auks	2,106.61
	<b>Total:</b>	<b>18,178.70</b>
(2) Seabird Proposed Predator Management	Cormorants	29,812.80
	Auks	6,454.29
	Storm-Petrels	651.86
	<b>Total:</b>	<b>36,918.95</b>
(3) Seabird Alternative Parcel B	Cormorants	24,667.16
	Auks	1,011.18
	<b>Total:</b>	<b>25,678.34</b>

**Calculating Restoration Credits: Shorebirds**

Table 12 provides an overview of the proposed and alternative shorebird restoration project options, which provide additional bird-days for migrating and wintering shorebirds. A bird-day represents one bird using the project area for one day. The figures presented reflect the total number of birds and their total time on-site, as measured by biologists' field surveys. From the general perspective of a REA, the 7,500 bird-days listed for sanderlings in 2006 under Project (4) could be 7,500 birds visiting for one day, 300 birds visiting for 25 days, 75 birds visiting for 100 days, etc. Because the debit side of the REA was measured in lost bird-years, the restored bird-days are divided by 365 days per year to result in bird-years. These bird-years are then converted to present value to identify the total restoration credits expected from the projects. Unlike the seabird restoration projects, which focus on providing nests to produce more birds, future generations are not considered in the shorebirds analysis. The shorebird restoration projects are specifically intended to provide resting and feeding grounds, as measured by bird-days. The final results for each project are provided in Tables 13 and 14. Table 15 provides a summary of the restoration credits.

**Table 12**  
**Restoration Project Options: Shorebirds**

<b>Restoration Project Options</b>	<b>Benefits to Shorebirds</b>			
(4) Shorebird Proposed Acquisition A	Acquisition and restoration of pasture to tidal marsh, starting in 2006, is expected to protect and then increase shorebird-days by 2007. The number of bird-days in 2006 reflects the most recent estimate of current use. 2007 reflects expected increases from restoration, which are assumed to continue in perpetuity with proper management.			
	<b>Species</b>	<b>Baseline Bird-Days (2006)</b>	<b>Total Bird-Days (2007)</b>	<b>Net Restored Bird-Days (2007)</b>
	Dunlin	16,500	40,500	24,000
	Western Sandpiper	33,000	81,000	48,000
	Least Sandpiper	17,250	42,000	24,750
	Pectoral Sandpiper	375	938	563
	Red Knot	750	1,875	1,125
	Sanderling	7,500	18,750	11,250
	Turnstones	2,600	3,900	1,300
	Yellowlegs Sp.	2,250	4,875	2,625
	Dowitcher Sp.	16,500	40,500	24,000
	Black-bellied Plover	3,000	7,125	4,125
	Semipalmated Plover	2,250	5,625	3,375
	Killdeer	16,250	5,000	-11,250
	Whimbrel	1,950	4,500	2,550
Long-billed Curlew	28	70	42	
Marbled Godwit	350	875	525	
<b>Total Bird-Days:</b>	<b>120,553</b>	<b>257,533</b>	<b>136,980</b>	

Restoration Project Options	Benefits to Shorebirds		
(5) Shorebird Alternative Property 1	Acquisition of easements on coastal grasslands, restoration of pasture to wetland habitat, and improved pasture management starting in 2006, is expected to protect and then increase shorebird-days. The number of bird-days in 2006 reflects the most recent estimate of current use, which are conveyed at the time of acquisition. 2007 reflects expected increases from restoration, which are assumed to continue in perpetuity with proper management.		
	Species	Acquired Baseline Bird-Days (2006)	Total Restored Bird-Days (2007)
	Sanderling	13,500	27,000
	Western Sandpiper	45,000	180,000
	Dunlin	22,500	67,500
	Least Sandpiper	22,500	90,000
	Yellowlegs Sp.	6,750	20,250
	Dowitcher Sp.	13,500	27,000
	Black-bellied Plover	9,000	13,500
	Semipalmated Plover	6,750	8,439
	Killdeer	45,000	33,750
	Whimbrel	135,000	405,000
	Marbled Godwit	1,680	2,100
	Long-billed Curlew	630	789
	<b>Total Bird-Days:</b>	<b>321,810</b>	<b>875,328</b>

Source: Lowe, Roy W., D. Pitkin 2004. Estimated bird use for potential seabird and shorebird restoration projects for the *M/V New Carissa* NRDA. Memo to Trustees, October 7, 2004. Clarified by US FWS on September 23, 2005.

**Table 13**  
**Total Restored Bird-Years in PV**  
**Project (4): Proposed Acquisition A**

Year	Discount Factor	Total Restored Bird-Years	Total Restored Bird-Years in PV
2007 in perpetuity	30.50*	375.29	<b>11,448.046</b>

\*Perpetuity calculation:  $1 \div [1.03^{(2007-2004)} \times 0.03] = 30.50$

**Table 14**  
**Total Restored Bird-Years in PV**  
**Project (5): Alternative Property 1**

<b>Year</b>	<b>Discount Factor</b>	<b>Total Restored Bird-Years</b>	<b>Total Restored Bird-Years in PV</b>
2006	0.94	881.67	831.060
2007 in perpetuity	30.50*	2,398.16	73,155.171
			<b>73,986.230</b>

\*Perpetuity calculation:  $1 \div [1.03^{(2007-2004)} \times 0.03] = 30.50$

**Table 15**  
**Summary of Total Restoration Credits in PV: Shorebirds**

<b>Restoration Project Options</b>	<b>Restored Bird-Years in PV</b>
(4) Shorebird Proposed Acquisition A	<b>11,448.046</b>
(5) Shorebird Alternative Property 1	<b>73,986.23</b>