Appendix G

Marbled Murrelet REA Details

INJURY CALCULATION

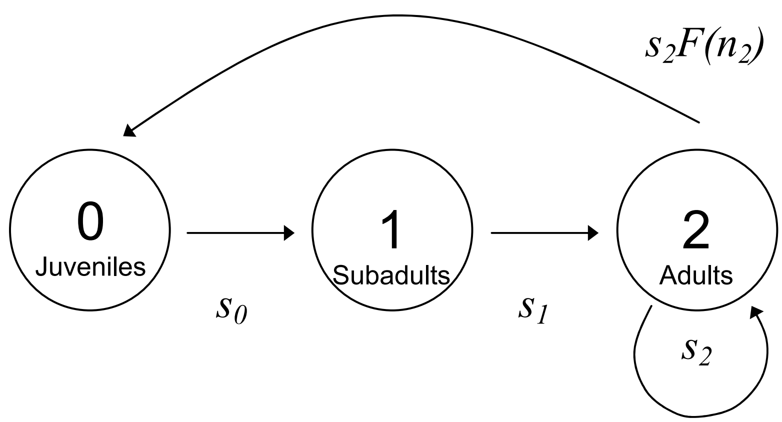
The Trustees calculated the injury based upon female bird-years, assuming a 1:1 sex ratio. This implies that a 135 bird acute mortality translates into an immediate loss of 65.5 female birds from the local population. We used 65 females for our injury modeling.

The discounted bird-year injury (or debit, D) was based upon the following formula:

$$D = \sum_{t=1999}^{2098} \frac{N_{BI,t} - N_{I,t}}{(1+d)^{t-1999}} \qquad (1)$$

Here, $N_{BI,t}$ is the numbers of female birds in the subpopulation in period t had the spill not occurred, and $N_{I,t}$ is the number of female birds in the subpopulation at period t after the spill. For example, if we assume that the size of the injured population was 2100 females at the time of the spill and 65 females were killed, then $N_{BI,1999}$ = 2100 and $N_{I,1999}$ = 2100 – 65 = 2035. The parameter d is the discount rate. This is set at d = 0.03, consistent with federal NRDA guidance for a risk-free discount rate.

To calculate the trajectories $\{N_{BI,t}\}$and $\{N_{I,t}\}$, we use the following re-parameterization of the Beissinger (1995) model.



(2)

The parameters s0, s1, and s2 are the survivorships for juveniles, subadults and adults, respectively. The term $s_2F(n_2)$ reflects the "post-breeding" census convention (i.e., bird-years are counted in the Fall). This implies that adult Murrelets (n2) must survive (s_2) before they are able to attempt successful breeding ($F(n_2)$). In the model, fecundity increases as the population becomes smaller (i.e., $dF(n_2)/dn_2 < 0$). This reflects the possibility that, as a population declines, it will tend to decline faster in more marginal areas leaving the remaining birds in higher quality habitat.

Combining the trajectories projected from (2) into Equation (1) yields our injury estimate of lost bird-years.

CREDIT CALCULATION (projected restoration benefits)

The overall benefit of the land acquisition and management is scaled based upon the benefit of the project at an individual nest (in discounted female bird-years). The number of nests that need to be protected to compensate for the injury ($N_{Acquire}$) is based upon: (1) the size of the bird-year injury; and (2) the benefit of land acquisition to nesting birds and their offspring (in discounted female bird-years). This is written as:

$$N_{Acquire} = \frac{D}{B_{nest}} \qquad (3)$$

where D is the marbled Murrelet injury from (1) (measured in discounted female bird-years), and B_{Nest} is the benefit of the project per nest affected (in discounted female bird-years per nest).

The benefits per nest (B_{Nest}) are calculated over a 100 year period, according to the formula:

$$B_{Nest} = \sum_{t=1999+t_{\log}}^{2098} \frac{N_{R,t} - N_{BR,t}}{(1+d)^{t-1999}} \qquad (2)$$

Here, $N_{R,t}$ is the expected numbers of female birds supported by a nest within an acquired site at time t.[1] $N_{BR,t}$ depicts the fate of the birds supported by the acquisition site at time t after logging. t_{log} is the number of years between spill and logging without the acquisition project. The parameter d is the discount rate, which is set at 0.03.

The trajectories for $N_{BR,t}$ and $N_{R,t}$ are based upon the same basic modeling framework as used in the injury calculation. However, there are two differences between the calculation performed here and the calculation used in the injury model. First, the model is applied at the "nest" scale, versus a local population scale. This implies that we follow the number of birds associated with a given nest (versus the entire local female MAMU population). Second, we assume that: (a) with acquisition, nests are sufficiently productive to maintain population levels ($\lambda = 1.0$); and (b) without acquisition, associated birds will reproduce at lower fecundity ($\lambda < 1.0$) after logging occurs ($t_{log} = 2004$).

[1] This would include one adult female per nest, along with corresponding sub-adults, juveniles, and potentially non-breeding adults.