Assessment of Risk to Marbled Murrelets (*Brachyramphus marmoratus*) of Forest Policy Alternatives in British Columbia

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Extended Abstract: We conducted a conservation risk assessment of alternative forest policies on nesting habitat of the marbled murrelet (*Brachyramphus marmoratus*) in British Columbia. This small seabird (family Alcidae) nests predominantly on large, mossy limbs of old-growth trees within 50 km of salt water (Burger 2002). The species is found only on the western coast of North America, and is presently classified as Threatened under the *Species at Risk Act* (SARA). The loss of old-growth nesting habitat has been the primary conservation concern to date for this species.

We examined the influence of amount and composition of old-growth forest and timber harvesting-induced edge on marbled murrelet nesting carrying capacity, population size, and relative persistence probability. We considered persistence probability to be an indicator of population resilience; a more resilient habitat scenario means the population can better absorb periods of poor at-sea survival or productivity, is less reliant on immigration from elsewhere, and is less sensitive to uncertainty about habitat relationships.

The assessment was cast within a Bayesian belief network (BBN) model to facilitate the inclusion of uncertainty weightings of demography, at-sea environmental conditions, expert opinion of parameter estimates, and current understanding of murrelet biology. Combined through the BBN, these uncertainties result in a probability distribution of possible outcomes—a more resilient policy is indicated by a shift towards outcomes of higher persistence probability.

The analysis was applied first in a non-spatial form to the six Canadian Marbled Murrelet Recovery Team conservation regions, and at two temporal scales (100 and 300 years) coast wide (Steventon et al. 2003a, 2003b). For the coast-wide persistence estimates, we combined regional estimates using the 'bet-hedging' approach of Boyce et al. (2002). The framework was then used to assess a spatially explicit land use scenario for a 1.5-million hectare region of northern coastal British Columbia (Steventon 2003) by incorporating competing versions of a habitat suitability index model and a marine radar-based population survey. Along with assessing proposed land management scenarios, the model can be used proactively to suggest amounts, types, and spatial

distribution of old-growth stands that are consistent with varying nesting capacity and/or persistence risk objectives (Steventon et al. 2003a, p. 28).

Marbled murrelet population size and persistence were most sensitive to at-sea demography assumptions, amount of old growth retained, and nesting density estimates. Management-induced edge effect on nesting success had only a weak influence. Improvement in relative persistence probability for a regional subpopulation began to diminish above a nesting carrying capacity of 2000 pairs per region. Sensitivity of persistence to habitat quality (nesting density) and demography assumptions diminished above 400,000 ha of old-growth habitat per region.

Scenarios providing a persistence probability of ≥ 95% at 100 years also maintained high persistence probability at 300 years, the length of time it may take for harvested areas to recover as replacement murrelet nesting habitat. Starting with recent working population estimates (Burger 2002), coast-wide persistence remained close to or above the 95% threshold with a simulated further 30% reduction in nesting capacity among regions, but there was much less certainty of outcome for some individual conservation regions.

Selecting an appropriate management policy depends on the degree of acceptable risk to the decision maker, the cost of risk reduction, and trade offs among spatial scales and regions. Even without an explicit expression of risk aversion or utility, however, policies can be screened using formal decision analysis for ability to reduce conflict and to help identify key uncertainties to be addressed through research and adaptive management.

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