Experiments on Edge Effects in Marbled Murrelets:
Incorporating Reproductive Performance into Habitat Quality

David B. Lank
Center for Wildlife Ecology
Simon Fraser University

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I. BACKGROUND

The Marbled Murrelet is a seabird of conservation concern that nests in large, mossy branches of old growth trees (Ralph et al. 1995). Documentation of population declines in locations throughout its breeding range (Klosiewski and Laing 1994, Kelson et al. 1995, Strong 2003) has created concerns regarding the demographic consequences of continuing harvest and fragmentation of old-growth habitat (Burger 2002). The establishment of adequate habitat reserves of terrestrial habitat has been proposed as a management priority to ensure sustainable populations of murrelets (Burger 2002, McShane et al. 2004). However, this process has been hampered by the uncertainty regarding the relative value of different size patches of forests for nesting murrelets. Small forest patches may be less productive due to their high proportion of edge habitat, which is often subjected to higher rates of nest predation (Paton 1994, Batáry and Báldi 2004, but see Lahiti 2001). Nest predation may be elevated at edges if predators such as corvids preferentially use edges as travel lines (Andrén 1995), forage disproportionately along edges due to higher densities of prey (Gates and Gysel 1978), or if nests at edges have higher risk of predation due to lower nest-site cover (Ratti and Reese 1988). Edges may also be detrimental to nesting murrelets as a result of less hospitable microclimate regimes found in these habitats (Burger 2002, McShane et al. 2004). Increases in temperature and solar radiation at edges may cause thermal stress or dehydration in murrelet chicks at clearcut edges (Binford et al. 1975), or reduce the growth and recruitment of mossy nesting platforms.

However, the evidence is equivocal as to whether small patches and forest edges actually negatively impact murrelet productivity. While some researchers have found samples of successful nests to be significantly farther from edges than failed nests (Nelson and Hamer 1995, Manley 1999), others have found no significant difference in nest success between nests adjacent to or far from edges (Bradley 2002; Zharikov 2006, 2007). In addition, murrelets appear to nest disproportionately near both natural edges such as streams and avalanche chutes, as well as anthropogenic edges such as clearcuts and regenerating forest (Nelson and Hamer 1995, McShane et al. 2004, Zharikov et al. 2006, 2007). This seemingly paradoxical preference likely reflects a requirement of this heavily wing-loaded bird for safe access to nest sites for adults, and clear flight paths for fledgling chicks (Manley 1999). This observation highlights the importance of determining the extent of edge effects on murrelets, as a preference for edges may be maladaptive in industrially fragmented landscapes. We are currently investigating the local and landscape-level factors that influence the presence of edge effects for Marbled Murrelets. These data will be used to refine policies for recognizing the potential value of existing areas of habitat and for guiding the selection of additional areas.

II. METHODS

FIA funding covered: (1) much of the cost of completing our 2006 field studies of edge effects using simulated nests, working in two regions of BC: on SW Vancouver Island between Suk and Port Renfrew, and in areas northeast of Squamish and Schelt, and (2) provided support for completion of Josh Malt’s MSc thesis, which analysed similar data collected previously around Desolation Sound and in the Nimpkish Valley.

Nest predation risk at edge and interior: At each experimental site, simulated nests were placed on suitable murrelet platform (RIC 2001), as selected by professional tree climbers who had expertise in finding real murrelet nests. A simulated egg and nestling were placed in separate trees within 50 meters of the habitat edge (Paton 1994) and 150-250m from the edge in the forest.
interior, for a total of 4 nests at each site. We minimized human scent by storing the eggs and chicks in bark mulch, and using latex gloves at time of nest placement. Simulated eggs were constructed from plastic egg casings painted to mimic murrelet eggs and covered in wax. The wax coatings enabled us to identify the teeth or beak marks from the predators, which will be calibrated using museum research skulls. Simulated nestlings were created from skinned and ‘boraxed’ *Coturnix* quail, whose plumage is of similar colour to that of a downy murrelet nestling. All potential predators seen or heard during the duration the nest set-up were recorded at each site. In 2004, time to disturbance was determined by placing movement sensitive radios in eggs and nestlings. In 2005 all nests were monitored with motion-sensitive cameras to determine the time to predation and identify predators. In 2006 most, but not all nests were similarly monitored with cameras.

**Influence of edge type:** Using spatial data of forest cover and cutblock history, we selected sites with a minimum area of 20 hectares (i.e. radius of 250m) of old growth forest (>150 years old), adjacent to one of three types of forest openings. “Hard-edge” sites were located adjacent to recent clearcuts (5-11 year old), “Soft-edge” sites next to regenerating stands (17-39 years old), and “Natural-edge” sites were established in riparian areas next to large rivers.

**Predator Surveys:** In 2005 and 2006, we established survey stations at 17 or 18 sites per region, with 5 or 6 replicate survey sites for each edge type, paired with experimental sites. We established 4-5 point count stations at each site (Ralph et al. 1993), along parallel transects at the forest edge and 150m into the forest interior, at least 100m from any other edge. Station centres were 150m apart, so that distances between 2 adjacent detection radii fit the minimum requirement of 50m. Sampling periods at each station were 10 minutes in duration, during which all potential predators seen or heard were recorded. When a predator was initially observed, the distance to that predator was measured using a laser rangefinder (+/- 1m), or estimated if the observation was audio. We were able to detect both avian predators (i.e. corvids and raptors), as well as resident squirrels, which were detected by territorial calls. We did not limit our surveys to the early morning, as corvids, are active throughout the day (Luginbuhl et al. 2001).

In addition to these data, extensive bird survey data collected along road survey routes for CANFOR Ltd. were made available to us for integration with our analyses of patterns in the Nimpkish Valley.

**Habitat/Microclimate Sampling** In 2005 and 2006, we instrumented one nest at most sites with temperature or temperature/humidity data loggers. In addition, during nest retrieval, one of the experimental nest trees was chosen at random (egg or nestling) from each edge and interior location to represent the habitat characteristics of that area. The tree height, number of potential platforms, and mistletoe score were measured for each tree. For each platform on the tree (as per RIC 2001), climbers measured maximum epiphyte depth, epiphyte cover, and number of secondary platforms. For each “nest site” of the selected tree, platform length, width, and depth were measured, and vertical % cover and horizontal % cover (in the cardinal directions) were estimated. All canopy trees (or >10 cm dbh) within a 25m radius of the nest tree were sampled. Diameter at breast height (dbh) was measured and height was estimated by comparing it to the measured height of the nest tree. In addition, the canopy layer, number of potential platforms, epiphyte cover (0-4 rating), epiphyte thickness, and mistletoe score were estimated for each tree.
We used HOBO Temperature/Humidity dataloggers (Onset Computer Corp.) and ibutton (Dallas Semiconductor/Maxim) at samples of edge and interior sites to characterize the temperature and humidity regimes in effect at canopy levels. Dataloggers were programmed to sample temperature, dew point, absolute humidity, and relative humidity every 15 minutes.

III. DELIVERABLES

The contract between SFU and Interfor specified the following deliverables:

1) Conduct two field studies on edge effects during June, July and August. Each study will be comparable in scale with those conducted in the past two years. During the summer of 2006, we will work (1) in the Squamish area and Sunshine Coast, and (2) on SW Vancouver Island, between Sooke and Pt. Renfrew. Summaries of the results will be available by March 2007.

The 2006 fieldwork was completed substantially as planned. Total sample sizes and outcomes from experimental nests from all years are shown below:

<table>
<thead>
<tr>
<th>Year</th>
<th>Region</th>
<th># of experimental sites</th>
<th># of experimental nests</th>
<th>% nests “predated”</th>
<th># Predator survey sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Desolation Sound, mainland BC</td>
<td>18</td>
<td>66</td>
<td>41</td>
<td>6</td>
</tr>
<tr>
<td>2005</td>
<td>Nimpkish Valley, Vancouver Island</td>
<td>35</td>
<td>136</td>
<td>55</td>
<td>18</td>
</tr>
<tr>
<td>2006</td>
<td>Squamish and Scheldt region, mainland BC</td>
<td>29</td>
<td>115</td>
<td>52</td>
<td>18</td>
</tr>
<tr>
<td>2006</td>
<td>Suk-Port Renfrew region, Vancouver Island</td>
<td>35</td>
<td>139</td>
<td>47</td>
<td>17</td>
</tr>
</tbody>
</table>

The 2006 studies produced results with similar total “predation levels” as in previous years, with about half of the sites detected and disturbed by potential predators. We should thus have adequate variance to detect treatment effects, as proved practicable for the 2004 and 2005 sites (Malt 2007). With ongoing NSERC funding, I have hired newly-graduated Josh Malt to work with me to analyze the entire data set within the coming 6-9 months. We will produce both reports for our industrial clients and manuscripts for submission to appropriate journals.


Malt’s thesis was completed in mid-April, and a copy of it is attached as an Appendix to this report.
IV. ACKNOWLEDGEMENTS

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V. REFERENCES


