Avian Community Dynamics in a Coastal Forest Landscape
– Clearcuts, Grouped Retention, Old-growth Benchmarks –

– Progress Report –

FINAL COPY

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Executive Summary

This project is intended as part of a Master's of Science program at Simon Fraser University that will commence in 2003 under the supervision of Dr. Alton Harestad. This study, which uses birds as response variables, was completed in "Block 2" of TFL 39 of Weyerhaeuser Corporations' forest tenure. Three hypotheses were developed to compare differences between species abundance and presence in traditional clearcuts, grouped variable retention harvest sites, and uncut old-growth benchmark forests. Two specific methodologies were developed to make comparisons of site usage by different species at two scales: the treatment level and the site level.

For treatment comparisons, 12 sites were selected for each of the clearcut, grouped retention, and old-growth benchmark categories. Within each site, five point count stations were established. Each point count station was surveyed three times, thus yielding 540 point counts. There were 2,293 total detections (45 species), with 439 in clearcuts (31 species), 821 in grouped retention (39 species), and 940 (25 species) in old-growth benchmarks. The Chestnut-backed Chickadee and Golden-crowned Kinglet had significantly greater average abundance in old-growth than in grouped retention and clearcut sites. Mean abundance of Hammond's Flycatcher and Red-breasted Sapsucker in variable retention sites was significantly greater than in clearcuts, but did not differ significantly from old-growth. The Pacific-slope Flycatcher and Brown Creeper had significantly greater abundance in old-growth than in clearcuts, but similar to values found in variable retention sites.

For the species mapping component, 73 point count stations were arranged in a 50 x 50 m grid throughout grouped retention cutblock R799. A total of 219 surveys
yielded 1,057 observations of 27 species. Sufficient sample sizes for American Robin (n = 291), White-crowned Sparrow (n = 254), Spotted Towhee (n = 87), Song Sparrow (n = 80), Dark-eyed Junco (n = 56), and Red-breasted Sapsucker (n = 52) were enough to suggest that the feasibility of carrying out this project in more detail was warranted. Two plots, one for each of American Robin and Winter Wren, were produced for the purpose of visualizing the distribution and frequency of use three dimensionally. Further analysis will require comparisons between availability of habitat types and their actual frequency of use by individual species to determine if use intensity is different from what would be expected by chance alone.

In early 2003, discussions with project supervisor Dr. Alton Harestad will focus on developing specific attributes for the thesis project. Discussions with Pierre Vernier (University of British Columbia) will emphasize the incorporation of data from the thesis project into a second study on developing habitat suitability index models for species at the landscape level. The criteria for both projects will meet the goals of the Adaptive Management Working Group.
Preamble

This study is intended as part of a Masters of Science program commencing in 2003 at Simon Fraser University, supervised by Dr. Alton Harestad. This report summarizes the findings from baseline field work completed in the summer of 2002. Detailed analyses and a complete investigation of the hypotheses will be presented in the M.Sc. theses and subsequent peer-reviewed papers expected at the completion of the degree program.

Introduction

The variable retention harvest system (VRHS) first emerged during the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound (1995) on western Vancouver Island. In mid-1999, MacMillan-Bloedel Corporation initiated the gradual phase-out of clearcut logging in exchange for variable retention as its primary silvicultural system (Dunsworth and Beese 2000). The VRHS is an evolving concept, initially designed to retain structural and ecological elements of a living old-growth forest. Today, the concept of variable retention continues to develop, with such issues of structural representation, flora and fauna representation, minimum retention requirements, spatial design, and temporal impacts at the forefront of the decision-making process (Lindenmayer and Franklin, 2002). In fact, the VRHS focuses more on what is left behind rather than what is removed (Lindenmayer and Franklin, 2002), thus fitting into the Adaptive Management model.
The BC Coastal Forest Project of Weyerhaeuser Corporation (formerly MacMillan Bloedel) implemented three classifications of the variable retention harvest system. These include:

1) **Grouped (Aggregate):** small, intact areas of forest, usually ranging from 0.25 to 1.0 ha of varying shape, composition, and spatial distribution;

2) **Dispersed:** retention of individual trees or small groups of trees (<0.25 ha) spaced near-equally across the entire cutblock with varying age and species; and

3) **Mixed:** a combination of grouped and dispersed retention

The amount of forest retained through the VRHS (typically 10-20%) is over and above those reserves already retained through other forest management programs (i.e., stream buffers, wildlife trees). However, where limitations inhibit a “preferred” quota (e.g., 10% instead of 15%) of retention through the VRHS, retention design is engineered so as to complement other reserve systems such that structural and ecological representation are perceived as maximal.

Traditional clearcutting methods remove structural elements on which different species may depend for their survival. Additionally, with an increasing loss of forest attributes from the ecosystem, an increasing degree of contrast in ecological diversity between forested and non-forested regions is observed (Lindenmayer and Franklin 2002; Schieck et al. 1995). The idea of variable retention forestry is that if structural attributes that species depend upon for survival are retained, then so to should the species that depend on them. This has been demonstrated in residual tree patches (Schieck et al. 2000; Steventon et al. 1998; Merrill et al. 1998) and isolated wildlife trees.
patches (Seip and Parker 1997), where bird communities were more similar to old-growth forests than to clearcut regions.

There are three primary functions of variable retention that are not typically achieved through traditional clearcutting methods:

1) to act as a lifeboat mechanism by providing refugia for elements of biological diversity that might otherwise be lost by clearcut methods;
2) to provide structural enrichment by retaining those features that might otherwise be lost during clearcut methods, and
3) to enhance connectivity between forested units such that organisms are more easily able to migrate or disperse among the environment (Franklin et al. 1997).

Despite earlier studies that show species retention in forest patches, little work has been done to assess the multi-patch framework that grouped variable retention presents. Furthermore, almost no work has been done to compare differences in species assemblages and community dynamics between clearcuts, grouped retention, and old-growth forests.

As part of Weyerhaeuser’s multi-faceted approach to monitoring ecological and structural impacts of variable retention, this study focuses on the community dynamics of British Columbia’s diverse avifauna in all three of the aforementioned forest types. Three primary hypotheses were defined as:

1) If grouped retention harvest techniques retain structural and ecological features required by species that live in uncut forests, then those species should be present in grouped retention cutblocks in greater abundance and frequency than in
clearcuts. Furthermore, if enough structure is sufficiently retained (suggesting a critical threshold limit), then the abundance of species associated with grouped retention should be similar to uncut forests with similar attributes.

2) If species abundance or presence is associated with specific structural or spatial attributes, then those species should have greater abundance or frequency of occurrence when increasing amounts of those structural attributes are retained as compared to when they are not. Therefore, species dependent on old-growth forest attributes should occur more frequently in grouped variable retention sites than in clearcuts, but less frequently than in stands that are completely uncut. Those species that are associated with the structural attributes of clearcuts should occur less frequently than in grouped retention, and even less frequently in old-growth benchmarks. Species that demonstrate an affinity for edge-associated attributes should be relatively more common in grouped retention than in clearcuts and older forests respectively; and

3) If structural elements on the ground directly influence a species’ distribution, abundance, and movement patterns in a given cutblock, then associations with those elements should be predictable and mappable. Therefore, species associated with structural attributes of large patches or edges should have greater frequency of detection in those habitats than those species that avoid large patches or edges.

This report summarizes the methods developed to collect the information required to test these hypotheses, and provides an initial overview and analysis for data
collected in summer 2002. Modifications in study design, a brief discussion of the results, and a 2003 progress plan are also presented.

**Methods**

**Study Area**

The area defined by this study included the woodland operational regions of Kelsey Bay, Menzies Bay, and Eve River. Collectively, these areas are referred to as “Block 2” or “North Island Woodlands” and roughly cover the area from Menzies Bay in the south to Robson Bight in the north, with western boundaries near Schoen Lake, Jessie Lake, and Brewster Lake. Using the British Columbia Biogeoclimatic Ecosystem Classification scheme, all study sites were in the Coastal Western Hemlock (CWH) and Coastal Douglas-fir (CDF) subzones.

Three treatment types were defined as:

1) old-growth benchmarks (> 90 years old, > 200 ha in size, > 90% retention);

2) recent clearcuts (< 6 years old, < 5% retention); and

3) grouped retention (< 6 years old, 10-38% retention distributed in patches ranging from 0.25 to 1.5 ha in varying quantity and configuration).

Twelve sites of each treatment were selected non-randomly, as the number of available sites for each treatment was limited. From a geographic perspective, however, sites were chosen so that each treatment would be represented in any given region so as to distribute variation related to elevation, latitude, longitude, over all treatments. A list of treatments, sites, and plots are given in Appendix 1.
Data Collection for Treatment Comparisons

Bird surveys were completed using point-counts (Ralph et al. 1995; Bibby et al. 1992). Given the type of environment being assessed, a survey time of 10 minutes was used with the intent to maximize species detectability and reduce standard error (Smith et al. 1998). Surveys were carried out from 18 May to 2 July 2002, with point count start times beginning at sunrise and ranging from 0515 to 1005 hrs.

Point count stations were selected by overlaying a 200 x 200 m grid on a 1:5,000 cutblock map. The 200 m boundary was determined in part from literature as the best size to maximize the probability that the detection of any given species is independent of any other. This spacing also allowed for up to 20 potential count stations to be selected from inside the cutblock boundary. Each intersection on the grid was numbered, and through the Microsoft Excel Random Number Generator, five study plots were randomly selected from each site.

For safety purposes, two observers sampled a single cutblock together, although only one person visited each count station. The observer approached each count station on foot, and upon arrival waited one minute to compensate for possible disturbance effects. Using a digital stopwatch, the observer then recorded each bird that was detected during the 10 minute period.

All detections were assigned a behaviour category based on first mode of detection (Table 1). Birds that were visually detected were assigned “site specific locations” to quantify structural attribute usage, and also to “treatment location” to quantify major features of the cutblock (Table 1).
Table 1. List of behaviours, site specific locations, and treatment locations used to describe observations of birds detected at point count stations for treatment comparisons and species mapping.

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Site Specific Location</th>
<th>Treatment Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singing</td>
<td>On Tree (conifer)</td>
<td>Clearcut (cut area of the cutblock)</td>
</tr>
<tr>
<td>Calling</td>
<td>On Tree (deciduous)</td>
<td>Patch (&gt;0.25 ha)</td>
</tr>
<tr>
<td>Displaying</td>
<td>On Wildlife Tree</td>
<td>Patch (&lt;0.25 ha)</td>
</tr>
<tr>
<td>Feeding / Foraging</td>
<td>On Regenerating Tree</td>
<td>Patch edge (within 5m cutline of &gt;0.25 ha patch)</td>
</tr>
<tr>
<td>Carrying Food</td>
<td>On Snag (&gt; 3m)</td>
<td>Matrix edge (5m boundary beyond cut line)</td>
</tr>
<tr>
<td>Nesting</td>
<td>On Stump (&lt; 3m) / DWM</td>
<td>Matrix (&gt;5m from cut line)</td>
</tr>
<tr>
<td>Distraction Display</td>
<td>On Shrub</td>
<td>Riparian Corridor (primarily deciduous or mixed)</td>
</tr>
<tr>
<td>Drumming</td>
<td>On Ground</td>
<td>Streamway (primarily conifer)</td>
</tr>
<tr>
<td>Flying</td>
<td>Flying (above canopy)</td>
<td></td>
</tr>
<tr>
<td>Perched</td>
<td>Flying (below canopy)</td>
<td></td>
</tr>
</tbody>
</table>

I used a count radius of 60 m to maximize detectability (based on previous years' work) and to maintain a minimum of 80 m between count edges of different plots. The distance from the observer to each individual bird was measured using a Bushnell laser sighting device, accurate to 0.5 m. The laser was bounced off of tree trunks, stumps, woody debris, and rocks that birds used as perches. In no cases were birds used as objects from which to bounce the signal from in the event that the laser may adversely affect the birds condition or behaviour.

Each site was replicated three times with a minimum of seven days between replicates. No observer visited the same site on all three occasions so as to distribute potential observer bias over all points. Within the morning survey period, each replicate for each site was surveyed only once in each of three time categories (early, middle, and late).

Additional information recorded during each survey included cloud (estimated % cover), wind speed (from modified Beaufort scale), precipitation, temperature (°C), and extra birds. The extra birds were recorded while walking into, and out of, count stations,
and were noted only for inventory purposes. In most cases, these observations did not duplicate those detected from point count surveys. A sample of the data sheet used for point counts is included in Appendix 2.

**Data Collection for Species Mapping**

Species mapping was used to define how individual species utilize ecological and structural attributes on the ground. In the latter half of the 2002 breeding season, preliminary measurements were taken to assess the feasibility of collecting and analyzing data to answer the third hypotheses.

In this preliminary test of the species mapping idea, one grouped retention site was selected for testing. The site was selected primarily on topography (minimal slope and relief) and site size (survey efficiency), keeping in mind that good representation (site remains in near original condition and meets criteria for grouped retention as defined by Weyerhaeuser Corporation) was essential. Once the site was selected, I used an engineered map (1:5,000) and a 50 x 50 m transparent grid to orient the number of count stations so as to maximize site coverage. Then, using a laser-sighted distance reader and compass, points were established at every intersection on the grid overlay. Each point was identified with a numbered flag on a thin metal rod pushed into the ground, and site numbers (1 to 73) were plotted on the 1:5,000 map. All points were subsequently logged using a Trimble GPS receiver (Figure 1).

Surveys were species specific, and data collected from treatment counts were used to determine the most appropriate target species. Those species with a relatively high frequency of occurrence, and association with forested and non-forested regions, were selected as priority. However, with time permitting, non-priority species were
recorded to determine future feasibility of sampling a larger proportion of the bird community.

![Figure 0. Location of point count stations (red dots) in R799 used for species mapping project. Top of picture is North.](image)

Point counts were conducted at every station using a 10 minute count period. Each point was sampled three times, using a different pattern of coverage so as to spread disturbance more evenly across the site. All detections of priority species
(Winter Wren, American Robin, MacGillivray’s Warbler, White-crowned Sparrow, Spotted Towhee, Red-breasted Sapsucker, Song Sparrow, and Hammond’s Flycatcher) were recorded, noting the time, distance, and compass bearing to each individual. If an individual moved from one location to another during the survey period, it was recorded a subsequent time. Observations of behaviour, site-specific location, and treatment location, also were recorded (See Appendix 3 for categories). Additional observations of non-priority species were recorded if they were thought not to interfere with priority-species data collection.

Once the data had been collected, a qualitative analysis was done to assess the logistics of a more intensive approach. As a result, initial frequencies of detection plots were produced at the 50 x 50 m scale to determine whether relationships between individual species and ground-based attributes existed visually. To ensure equal probability of detection in all grids, however, each grid was required to have four count stations (one in each corner). Then, because the distance from any given count station to the three stations that make up the grid ranged from 50 to 70.7 m, each data point had to be calculated using trigonometry to determine the exact location of occurrence. Data points recorded beyond any non-adjacent grid were excluded from analysis to ensure that each grid received equal sampling effort.

Results

Treatment Comparisons

A total of 12 sites of each treatment type were established. Each site had five point count stations, and each count station was sampled three times, yielding 540 point
count surveys. There were 2,293 observations from all sites, from which 83 observations were removed because they were the result of flyover activities not directly associated with the area being surveyed. There were 439 detections in clearcuts, 821 detections in grouped VR, and 940 detections in old-growth benchmark sites.

There were 45 species detected in all sites, including 31 from clearcuts, 39 from grouped VR, and 25 from old-growth benchmark sites. The Black-throated Gray Warbler and Merlin were unique to old-growth benchmarks. The Common Nighthawk, Northern Rough-winged Swallow, Sharp-shinned Hawk, and Vaux's Swift were unique to clearcut sites. The Brown-headed Cowbird, Cassin’s Vireo, Downy Woodpecker, European Starling, Ruffed Grouse, Violet-green Swallow, Warbling Vireo, and Willow Flycatcher were unique to grouped retention sites. It is noteworthy that all of these species, except Vaux’s Swift, occurred at low frequency.

Species-abundance curves were produced for each treatment type (Figures 1 to 3), with the shape of each curve fitting a lognormal distribution. Table 2 gives the estimated mean and variance of the lognormal distribution for each treatment, along with the expected number of species extrapolated from the truncated curve. In clearcuts, few species were relatively common, while comparatively more species were relatively uncommon. In old-growth benchmark sites, the opposite was true, whereby a broader range of species tended to be relatively common, and fewer species were uncommon. The species-abundance curve in grouped VR was between these two distributions.
Table 2 Estimated mean and variance of the lognormal distribution and extrapolated species richness for each treatment type.

<table>
<thead>
<tr>
<th>Parameter (lognormal)</th>
<th>Clearcut</th>
<th>Grouped VR</th>
<th>Old-growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>0.21</td>
<td>0.77</td>
<td>1.11</td>
</tr>
<tr>
<td>variance</td>
<td>0.62</td>
<td>0.57</td>
<td>0.48</td>
</tr>
<tr>
<td>species richness</td>
<td>42</td>
<td>42</td>
<td>26</td>
</tr>
</tbody>
</table>

Clearcut sites were dominated by Winter Wren (n = 169) and Dark-eyed Junco (n = 152), while the third most frequently detected species was Song Sparrow (n = 17) (Figure 2). Of the 31 species detected, 10 (32%) were unique to the matrix edge (Chestnut-backed Chickadee, Hammond’s Flycatcher, Red Crossbill, Golden-crowned Kinglet, Brown Creeper, Red-breasted Nuthatch, Townsend’s Warbler, Hermit Thrush, Red-tailed Hawk, and Sharp-shinned Hawk) and did not use wildlife trees, the cut over area, or the small patches that were part of the <5% retention. Among the top nine most abundant species in all treatments, the Dark-eyed Junco was the only species to have a mean abundance in clearcuts higher than grouped retention and old-growth benchmarks (Table 3).

In grouped retention sites, the Winter Wren (n = 180) and Dark-eyed Junco (n = 117) were the most frequently detected species, with American Robin (n = 61), Chestnut-backed Chickadee (n = 58), Hammond’s Flycatcher (n = 52), and Red-breasted Sapsucker (n = 46) being well-represented (Figure 3). Unlike clearcut sites, only one of 39 species was detected in the matrix (Hermit Thrush) and not among other treatment location attributes. Among the top nine most abundant species in all treatments, the Hammond’s Flycatcher was the only species to have a mean abundance in grouped retention higher than clearcuts and old-growth benchmarks.
The mean abundance for Winter Wren in grouped retention was the same as for old-growth benchmark sites, although the standard error of the mean is slightly higher in the latter. The Chestnut-backed Chickadee, Golden-crowned Kinglet, Pacific-slope Flycatcher, Red-breasted Sapsucker, Varied Thrush, and Brown Creeper all had a mean abundance in grouped retention greater than in clearcuts.

In old-growth benchmark sites, the species-abundance curve more closely resembled a lognormal distribution than the clearcut curve. The Chestnut-backed Chickadee was the most frequently detected species (n = 199), with Winter Wren (n = 180), Golden-crowned Kinglet (n = 109), Pacific-slope Flycatcher (n = 85), Red-breasted Sapsucker (n = 69), Varied Thrush (n = 64), and Brown Creeper (n = 59) being well represented (Figure 4). Among the top nine most abundant species in all treatments, the Chestnut-backed Chickadee, Golden-crowned Kinglet, Pacific-slope Flycatcher, Red-breasted Sapsucker, Varied Thrush and Brown Creeper all had a mean abundance in old-growth benchmarks that was higher than in clearcuts and grouped retention (Table 3). The Hermit Thrush, which was virtually absent from clearcuts and grouped retention, was present in 7 of 12 sites (n = 13).

<table>
<thead>
<tr>
<th>Species</th>
<th>Clearcuts</th>
<th>Grouped Retention</th>
<th>Old-growth Benchmarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut-backed Chickadee</td>
<td>0.17 (± 0.09)</td>
<td>1.78 (± 0.38)</td>
<td>6.58 (± 0.60)</td>
</tr>
<tr>
<td>Winter Wren</td>
<td>4.69 (± 0.63)</td>
<td>5.00 (± 0.62)</td>
<td>5.00 (± 0.88)</td>
</tr>
<tr>
<td>Golden-crowned Kinglet</td>
<td>0.08 (± 0.06)</td>
<td>0.69 (± 0.09)</td>
<td>3.11 (± 0.48)</td>
</tr>
<tr>
<td>Pacific-slope Flycatcher</td>
<td>0.06 (± 0.04)</td>
<td>0.69 (± 0.23)</td>
<td>2.36 (± 0.51)</td>
</tr>
<tr>
<td>Red-breasted Sapsucker</td>
<td>0.36 (± 0.16)</td>
<td>1.44 (± 0.34)</td>
<td>1.92 (± 0.57)</td>
</tr>
<tr>
<td>Varied Thrush</td>
<td>0.11 (± 0.05)</td>
<td>0.53 (± 0.19)</td>
<td>1.78 (± 0.29)</td>
</tr>
<tr>
<td>Brown Creeper</td>
<td>0.06 (± 0.04)</td>
<td>0.81 (± 0.14)</td>
<td>1.64 (± 0.22)</td>
</tr>
<tr>
<td>Hammond’s Flycatcher</td>
<td>0.14 (± 0.10)</td>
<td>1.44 (± 0.33)</td>
<td>0.69 (± 0.32)</td>
</tr>
<tr>
<td>Dark-eyed Junco</td>
<td>4.42 (± 0.40)</td>
<td>3.31 (± 0.56)</td>
<td>0.42 (± 0.12)</td>
</tr>
</tbody>
</table>
A non-parametric comparison on the mean site abundance between treatments was done for the nine most frequently detected species across all treatments (Table 4). The Winter Wren was the only species to have similar abundance between treatments.
The Chestnut-backed Chickadee and Golden-crowned Kinglet had greater average abundance in old-growth than in grouped retention and clearcut sites (Table 4). Mean abundance of Hammond’s Flycatcher and Red-breasted Sapsucker in variable retention sites was significantly greater than in clearcuts, but did not differ significantly from old-growth. These two species were only marginally similar between old-growth and clearcut sites, with the former having greater abundance. The Pacific-slope Flycatcher and Brown Creeper were significantly greater in old-growth than in clearcuts, but similar to values found in variable retention sites. Only the Dark-eyed Junco was significantly more abundant on average in clearcuts that in old-growth sites. Numbers of Dark-eyed Juncos did not differ significantly between clearcuts and grouped retention, although the former had higher average abundance.

Figure 4. Lognormal distribution in species-rank order for plots surveyed in old-growth benchmark sites.
Table 4. Kruskall-Wallis one-way Analysis of Variance to test for differences in mean site abundance between treatments for the nine most frequently detected species. Degrees of freedom for all tests were 2,33. * Indicates parametric one-way AOV. Comparison of means shown in order from highest to lowest average abundance. CC = Clearcut, VR = grouped retention, OG = old-growth benchmark.

<table>
<thead>
<tr>
<th>Species</th>
<th>F</th>
<th>p</th>
<th>Comparison of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut-backed Chickadee</td>
<td>87.21</td>
<td>&lt; 0.01</td>
<td>OG &gt; VR &gt; CC</td>
</tr>
<tr>
<td>Winter Wren *</td>
<td>0.06</td>
<td>&gt; 0.95</td>
<td>OG = VR = CC</td>
</tr>
<tr>
<td>Golden-crowned Kinglet</td>
<td>70.37</td>
<td>&lt; 0.01</td>
<td>OG &gt; VR &gt; CC</td>
</tr>
<tr>
<td>Pacific-slope Flycatcher</td>
<td>13.27</td>
<td>&lt; 0.01</td>
<td>OG &gt; CC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OG = VR and VR = CC</td>
</tr>
<tr>
<td>Red-breasted Sapsucker</td>
<td>4.59</td>
<td>&lt; 0.02</td>
<td>VR &gt; CC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VR = OG and OG = CC</td>
</tr>
<tr>
<td>Varied Thrush</td>
<td>22.64</td>
<td>&lt; 0.01</td>
<td>OG &gt; VR = CC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VR = CC</td>
</tr>
<tr>
<td>Brown Creeper</td>
<td>48.08</td>
<td>&lt; 0.01</td>
<td>OG &gt; CC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OG = VR</td>
</tr>
<tr>
<td>Hammond’s Flycatcher</td>
<td>8.05</td>
<td>&lt; 0.01</td>
<td>VR &gt; CC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VR = OG and OG = CC</td>
</tr>
<tr>
<td>Dark-eyed Junco</td>
<td>39.40</td>
<td>&lt; 0.01</td>
<td>CC &gt; OG</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CC = VR</td>
</tr>
</tbody>
</table>

**Species Mapping**

A total of 219 point count surveys were completed, yielding 1,057 observations of 27 species. The American Robin (n = 291) and White-crowned Sparrow (n = 254) were the most frequently recorded species, with Spotted Towhee (n = 87), Song Sparrow (n = 80), Dark-eyed Junco (n = 56), and Red-breasted Sapsucker (n = 52) being the next most frequently recorded (Figure 5).
Frequency plots were produced to show how a species was distributed throughout an operational VR block. The Winter Wren was infrequently detected and had a relatively narrow distribution (Figure 6). The American Robin was more widely distributed (Figure 7) and utilized many more regions of the cutblock than did the Winter Wren.

Figure 5. Lognormal distribution in species-rank order for species-mapping counts in R799
Figure 6. Total number of detections for Winter Wren in R799. Grids represent 50 x 50 m blocks on the ground. A frequency of 1 has been used to illustrate area covered, therefore, actual observations are (n-1).

Figure 7. Total number of detections for American Robin in R799. Grids represent 50 x 50 m on the ground. A frequency of 1 has been used to illustrate area covered, therefore, actual observations are (n-1).
The American Robin was primarily associated with cut areas (Table 5) of the grouped retention site from which perching, foraging, and calling were the main behaviours (Table 5). The matrix edge and patch edge were used almost exclusively for perching (Table 5), which may have served to facilitate prey finding among cut areas. The Winter Wren, although infrequently detected, was primarily associated with patch and matrix edge, and tended not to be found in cut areas or in small patches (Table 5).

Table 5. Frequency of detection of behaviour classes by treatment location for American Robin and Winter Wren.

<table>
<thead>
<tr>
<th></th>
<th>American Robin (n)</th>
<th></th>
<th>Winter Wren (n)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cut Area (&gt;0.25ha)</td>
<td>Patch (&lt;0.25ha)</td>
<td>Patch Edge</td>
<td>Matrix Edge</td>
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<tr>
<td>Singing</td>
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<td>Calling</td>
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</tr>
<tr>
<td>Feeding / Foraging</td>
<td>13</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Carrying Food</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
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<tr>
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<td>Perched</td>
<td>141</td>
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<td>17</td>
<td>34</td>
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**Discussion**

**Treatment comparisons**

Species richness and abundance in grouped retention sites was more similar to old-growth benchmarks than clearcuts. This was particularly true for the abundance of Golden-crowned Kinglet, Pacific-slope Flycatcher, Red-breasted Sapsucker, Brown Creeper, and Hammond’s Flycatcher. Clearcut sites tended to have relatively few common species and several uncommon species, whereas grouped retention sites tended to have several common species and relatively fewer uncommon species.
In coniferous forests of central British Columbia, the majority of species found in unharvested areas have been found in post-harvest patches (Seip and Parker 1997). However, relative abundance of species associated with larger intact blocks of forests, is usually lower in patches than in continuous forest (Merrill et al. 1998, Seip and Parker 1997). In this study, retention levels have not yet been incorporated into data analysis, but predictions are that for species associated with continuous forest, species abundance will be positively associated with retention level. The rate of change, however, is expected to vary with the size of individual patches and their spatial configuration within the cutblock. For example, some species may respond differently to a 20% retention regime if retained trees are distributed as two equally sized and spaced patches, as opposed to five unequally sized and spaced patches.

Habitat availability, and thus retention level, is likely a critical factor in determining how many of each species is present in a forested landscape (Boutin and Hebert 2002; Andren 1994). In northern Alberta, boreal forest songbirds showed varying patterns of occurrence and abundance with varying retention levels, and it was predicted that a curvilinear relationship would develop between forest bird abundance and residual tree retention (Tittler et al. 2001). More importantly, from a structural standpoint, it was predicted that bird abundance would reach an inflection point as density and basal area of trees in retention stands approached those of unharvested stands (Tittler et al. 2001). Furthermore, Boutin and Hebert (2002) determined that for many species, approximately 30% retention would be sufficient to maintain pre-harvest numbers. Of the sites surveyed here, only two had retention levels greater than 25%, so analysis of the effects of retention level on species’ abundance will be difficult to
determine with reasonable power. In 2003, plans to add additional sites with retention levels ranging from 30 to 50% are being considered.

**Species Mapping**

Habitat selection can have important consequences on the survival and reproduction of individuals (Cody 1985). Conclusions about habitat preferences however can vary, and in some instances may not be reliable, depending on the spatial scale at which habitat attributes are measured (Pribil and Picman 1997, Orians and Wittenberger 1991). The retention of forest patches reminiscent of original forest structure undoubtedly provides new habitats (e.g., via edge effects, etc.), and it has already been shown that for many birds that dominate old-growth benchmark sites, representation is maintained in grouped retention. However, for virtually all old-growth bird species, average abundance is lower in grouped retention sites. This may be a direct result of habitat availability, but it may also be related to processes of habitat selection, and may vary with niche breadth of individual species. Habitat generalists are more likely to make use of new habitats than are habitat specialists, and thus habitat availability will be important for specialist species. One possible method of determining a species’ choice is to incorporate different scales of habitat measurement, and to analyze habitat relationships at the species or guild level.

The broad-scale approach of this study was invoked to make predictions of species’ distributions using such features of canopy height, stand age, distance to water, road density, and proportions of cut and uncut forest (Vernier and Preston 2002). The narrow-scale approach was to incorporate such variables as the density of different size classes of trees, tree species richness, shrub species richness, small plant cover,
snag density, volume of coarse woody debris, and distance to nearest patch or forest edge. The species mapping component was designed to address spatial attributes at the fine-scale, using dozens of point count surveys that will be overlaid on orthographic photos or engineered maps. From these, exact points of observation can be used to determine which attributes are being used by individuals, and what attributes determine their distribution and abundance within a grouped retention cutblock.

The results of the species mapping pilot project were encouraging, with over 1,000 detections of 27 species. Most notably was the spatial array of observations for selected species that appear to be linked to structural attributes on the ground. With at least 15 species having enough observations for spatial analysis, there is strong evidence to continue this component of the thesis research. The Winter Wren and American Robin were used as test species to demonstrate visually the potential for fine-scale structure and habitat analysis. Further analysis will require comparisons between availability of habitat types and their actual frequency of use by individual species to determine if use intensity is different than would be expected by chance alone.

In coastal British Columbia, the Winter Wren’s breeding habitat is most often associated with mature and second-growth forests of coniferous or mixed wood (Campbell et al. 1997). Consequently, most observations of individuals should be from those regions, with less detection elsewhere. Within the species mapping project, the Winter Wren was primarily associated with retained patches that were > 0.25 ha, patch edges belonging to patches >0.25 ha, and the forested matrix edge. Of the relatively few observations from cut areas and patches <0.25 ha, most were noted for the purpose of foraging rather than singing or territory maintenance.
The American Robin is one of British Columbia’s most widely distributed breeding songbirds and has been found nesting in the most diverse array of habitats (Campbell et al. 1997). In forested environments there is a general tendency to avoid the interior of dense mature forests, but to exhibit a preference for edges and openings in younger forests and riparian areas (Campbell et al. 1997). This pattern of distribution was exhibited in both components of this study, with the American Robin more frequently detected in grouped retention sites, where proportionately more edge was available than in clearcut or old-growth sites. The species mapping project complemented the treatment comparisons, showing most detections from edges and cut areas, rather than from patch interiors.

In addition to the above-mentioned species, future work should focus on Chestnut-backed Chickadee, Golden-crowned Kinglet, Red-breasted Sapsucker, Pacific-slope Flycatcher, Hammond’s Flycatcher, White-crowned Sparrow, Spotted Towhee, and Swainson’s Thrush to assess variable retention site use.
Future Research: 2003

Prior to the 2003 field season, discussions with project supervisor Dr. Alton Harestad (Simon Fraser University) will focus on developing specific attributes for the thesis project. Discussions with Pierre Vernier (University of British Columbia) will emphasize the incorporation of data from the thesis project into a second study on developing habitat suitability index models for species at the landscape level. The criteria for both projects will meet the goals of the Adaptive Management Working Group. Some considerations will include:

a) 2003 Field Work

- define ecological and structural attributes for species mapping project
- define ecological and structural attributes for treatment comparison project
- develop methods for recording ecological and structural attributes in the treatment comparison project
- develop methods for recording ecological and structural attributes in the species mapping project
- collect final season of data for treatment comparisons
- collect first full season of data for species mapping project
- record data for ecological and structural attributes at 350+ count stations
- record GPS locations for sites currently not on file (approx. 150 sites)
b) **Additional considerations**

- add “second-pass sites” to increase sample size for mid-retention levels
- examine existing grouped VR sites as potential species mapping sites;
  - choose sites representative of the overall tenure
- define specific objectives and constraints for species mapping project
- define predictions of the species mapping project more specifically
- overlay species information with orthographic photos or engineered maps for spatial analysis
### Appendix 1. List of Treatments, Site Numbers, and Plot Numbers

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# Appendix 2. Point Count Datasheet for Treatment Comparisons

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<td>Cloud Cover:</td>
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<th>Treat Loc.</th>
<th>Plot #:</th>
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## Extra Birds

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<td>On Tree (conifer)</td>
<td>Clearcut (cut area of the cutblock)</td>
</tr>
<tr>
<td>2</td>
<td>Calling</td>
<td>On Tree (deciduous)</td>
<td>Patch (&gt;0.25 ha)</td>
</tr>
<tr>
<td>3</td>
<td>Displaying</td>
<td>On Wildlife Tree</td>
<td>Patch (&lt;0.25 ha)</td>
</tr>
<tr>
<td>4</td>
<td>Feeding / Foraging</td>
<td>On Regenerating Tree</td>
<td>Patch edge (within 5m cutline of &gt;0.25 ha patch)</td>
</tr>
<tr>
<td>5</td>
<td>Carrying Food</td>
<td>On Snag (&gt;3m)</td>
<td>Matrix edge (5m boundary beyond cut line)</td>
</tr>
<tr>
<td>6</td>
<td>Nesting</td>
<td>On Stump (&lt;3m) / DWM</td>
<td>Matrix (&gt;5m from cut line)</td>
</tr>
<tr>
<td>7</td>
<td>Distraction Display</td>
<td>On Shrub</td>
<td>Riparian Corridor (primarily deciduous or mixed)</td>
</tr>
<tr>
<td>8</td>
<td>Drumming</td>
<td>On Ground</td>
<td>Streamway (primarily conifer)</td>
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<tr>
<td>9</td>
<td>Flying</td>
<td>Flying (above canopy)</td>
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<tr>
<td>10</td>
<td>Perched</td>
<td>Flying (below canopy)</td>
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## Appendix 3. Species Mapping Datasheet for Spatial Distribution

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### Point # Start Time

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<table>
<thead>
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<th>#</th>
<th>Behaviour</th>
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<tr>
<td>1</td>
<td>Singing</td>
<td>On Tree (conifer)</td>
<td>Clearcut (cut area of the cutblock)</td>
</tr>
<tr>
<td>2</td>
<td>Calling</td>
<td>On Tree (deciduous)</td>
<td>Patch (&gt;0.25 ha)</td>
</tr>
<tr>
<td>3</td>
<td>Displaying</td>
<td>On Wildlife Tree</td>
<td>Patch (&lt;0.25 ha)</td>
</tr>
<tr>
<td>4</td>
<td>Feeding/F</td>
<td>On Regenerating Tree</td>
<td>Patch edge (within 5m cutline of &gt;0.25 ha patch)</td>
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<tr>
<td></td>
<td>Foraging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Carrying</td>
<td>On Snag (&gt; 3m)</td>
<td>Matrix edge (5m boundary beyond cut line)</td>
</tr>
<tr>
<td></td>
<td>Food</td>
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<td>Nesting</td>
<td>On Stump (&lt; 3m) / DWM</td>
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<td>Distraction Display</td>
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<td>Flying</td>
<td>Flying (above canopy)</td>
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<td>10</td>
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Appendix 4. List of Species Detected from Treatment Comparisons

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Literature Cited


Seip, D. and K. Parker. 1997. Use of wildlife tree patches by forest birds in the subboreal spruce (SBS) zone. Extension Note # PG-08, Ministry of Forests, Prince George, BC.


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