NON-MIGRATORY BIRDS IN RIVERSIDE'S TFL 49 – TERRESTRIAL LANDBASE

Jim Herbers, Katherine Maxcy,
and Robert Serrouya

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INTRODUCTION

Species-level test of the coarse filter

A coarse-filter strategy of ecosystem management aims to maintain most of the native biota and natural ecosystem function of a defined area and is generally considered synonymous with ecological representation. Ecological representation seeks to represent a portion of all ecosystems in a network of protected or unmanaged areas throughout a given planning area. Ecological representation is increasingly considered one of the most important criterion for successful conservation area design; it forms the foundation for ensuring the persistence of biodiversity and ecosystem function (O'Neil 1995; Noss 1999). A well-designed system of representative ecosystems is likely one of the surest means of conserving biodiversity; it is an efficient and conservative approach proactively managing for biodiversity, known or unknown, at risk or not (Belbin 1993; Johnson 1999; Schwartz 1999). However, some portions of the landbase may be more economically attractive to include in a coarse-filter strategy because of existing constraints to harvesting. Riverside is currently working toward the implementation of a comprehensive system of ecological representation and landbase zoning to achieve economic, social, and ecological sustainability. Before committing portions of the landbase to these strategies, it is important to measure the potential for ecological representation in specific landbase types in TFL 49.

The standard landbase makes up 46% of the TFL and has few constraints to harvesting. The partially and lightly constrained landbases make up 43% of the forested area on TFL 49, and the fully constrained landbase makes up 9% of the area. Before landbase zoning can begin, the ecological contribution of these landbases, and ecosystems within these landbases, needs to be assessed. Herbers and Serrouya (2003) reported that the park and deciduous landbases (both designated as full constraints to harvesting) in TFL 49 had approximately 50% fewer live trees and snags than the standard landbase. However, large live trees, large snags, and CWD were generally comparable or more abundant in these same constrained landbases. Although there were clear differences in habitat attributes between parts of constrained and unconstrained landbase, ultimately, it is how species respond to these differences that matters. To confirm the ecological contribution of these constrained landbases, species-level tests are required to determine how well each landbase may be functioning to achieve ecological sustainability.

The species-level test of the coarse filter seeks to determine if different landbase types are functionally equivalent to different components of biological diversity. One means of assessing this is to measure species richness, composition, and relative abundance. Non-migratory birds are one component of biodiversity that may serve as useful indicators for assessing habitat quality between landbase types. During the winter, non-migratory bird species in TFL 49 depend almost completely on trees and snags for survival. These habitat characteristics are used to meet a number of life-history requirements including foraging, roosting, and protection from predators. As a result, we selected non-migratory bird species to assess landbases for their potential contribution to ecological representation.

We had four specific objectives associated with examining winter birds in the context of a coarse filter in TFL 49. First, to test the park for its contribution to ecological representation in ecosystems 7 and 16, and to examine the deciduous and disease landbase for their ability to make strategic contributions to ecological representation in TFL 49. Second, to establish baseline estimates for winter resident birds in the three largest ecosystems (7, 16, 23) in TFL 49. Third, to test the ability of winter-bird point count sampling to form a component of a long-term monitoring program for the TFL. Fourth, to identify specific species that are likely to serve as good indicators of forest management in TFL 49.

Species-level test of the medium filter

Managing forests to approximate natural disturbance regimes has been suggested as one strategy to maintain biodiversity in managed forests (Hansen et al. 1991; Bunnell 1995; Eng 1998). The underlying assumption of this approach is that species are adapted to the spatial and temporal variation produced by the natural disturbance regimes associated with a particular ecosystem (Bunnell 1995; Hutto 1995). Therefore, it is assumed that if harvesting resembles patterns of natural disturbance the ecological processes, structural complexity, and biological diversity are more likely to be maintained (Eng 1998). To approximate these processes innovative silvicultural practices (i.e., partial harvesting strategies) are increasingly being implemented.

The implementation of silvicultural strategies to approximate natural disturbance is relatively recent in British Columbia and evaluation of these strategies to meet biodiversity objectives has just begun. Further, the relevant control for management comparisons is unclear. Should variable-retention treatments be compared to old-growth controls or should they be compared to disturbance controls? Evaluations of partial retention strategies are often compared to old-growth controls (Chambers et al. 1999; Gunn and Hagan 2000). Very little research has been conducted comparing partially harvested stands to the naturally disturbed stands they are supposed to approximate (Schulte and Neimi 1998; Imbeau et al. 1999; Schieck and Hobson 2000). Both comparisons are relevant as the goals of partial-harvesting strategies can be used to maintain habitat for forest-dwelling species, and/or to maintain habitat for species dependant on natural disturbance such as fire. This latter comparison is of critical importance given that natural disturbance regimes such as fire have been altered from their historic frequency. The species that depend on natural disturbances to meet their life-history requirements may not be able to meet these requirements in the managed landbase where natural disturbances have been altered (Bunnell 1995; Hutto 1995).

Therefore, the main objective of the second part of this research was to compare the ecological function of partially harvested stands to unharvested controls and naturally disturbed stands using winter resident birds as indicators. The specific objectives were to compare the species richness and relative abundance of winter-resident birds between unharvested controls, partially harvested, clearcut, and naturally disturbed (*Armillaria* spp. and *Phellinus* spp infected, pine beetle infested) stands in TFL 49.

Winter-resident birds as indicators of habitat quality

Habitat limitation and population regulation may be most constraining during the winter for resident birds. Therefore, the assumption that higher bird density equates to higher habitat quality is likely more justified during the winter (Newton 1994). Availability of important resources such as foraging sites, roosting sites, and thermal cover may be critical factors determining the overwinter survival of many resident species (Manuwal and Huff 1987; Huff et al. 1991). Therefore, the use of different habitats by winter resident birds make them an indirect indicator of habitat quality (Manuwal and Huff 1987). For example, old-growth forests were preferred over young or mature forests in the winter when no such preference was detected during the breeding season (Manuwal and Huff 1987; Huff et al. 1991). This suggests that important resources were more available in old–growth, which resulted in greater habitat use by winter resident birds. Morrison et al. (1986) also found that resident birds used habitat differently in winter compared to summer by making greater use of canopy and subcanopy cover and more widely scattered large trees. Comparisons of the species richness, composition, and relative abundance of winter residents among different forest types and silvicultural treatments appear able to serve as indicators of habitat quality.

METHODS

Coarse filter non-migratory birds

Study design and field measurements

This study compared the community similarity and relative abundance of non-migratory birds in 6 landbase types in TFL 49: the managed landbase in ecosystems 7, 16, and 23, deciduous constraints, park constraints, and forest health constraints. The ecosystems are defined as 7 (mesic/submesic IDF), 16 (mesic ESSF/MS/ICH), and 23 (mesic/subhygric ESSF)(Serrouya et al. 2002). These three ecosystem groups make up approximately 81% of the forested landbase (137,850 ha) in TFL 49. We define the managed landbase as the partially, lightly, and standard management landbase (see Serrouya et al. 2002 for descriptions). Deciduous stands were dominated by aspen (*Populus tremuloides*), birch (*Betula papyrifera*), and alder (*Alnus* spp.). We define the forest health landbase as stands with root disease (where *Armillaria* spp. and *Phellinus* spp.-induced mortality is >12% as described by Hodge 2002) or bark beetle infestations. Hereafter we refer to the forest health landbase as natural disturbance. All park sampling took place in Shorts Creek. The dominant natural disturbance regime is type 4 (frequent stand-maintaining fires) for Ecosystem 7 and type 3 (frequent stand-replacing fires) for Ecosystems 16 and 23 (Biodiversity Guidebook 1995).

Forest overstory ages ranged from 90 to 150 years in the managed, deciduous, and park landbases. Disturbance stands ranged from 104 to 174 years. Managed and park landbases were structurally mature stands that had little or no history of logging. Three stands had a light entry approximately 30 years before present. Similarly, deciduous and disturbance stands may have experienced a limited degree of past logging (the constraints were often a result of past logging), however, all sampled stands were structurally mature. Stands were sampled from January 12th to February 24th, 2003.

We used unlimited-distance point counts to measure the non-migratory bird community in TFL 49. The point count method was selected over the transect method to increase censusing precision (Herbers and Maxcy 2001). Within each replicate, point counts were spaced systematically at 200 m intervals. To ensure that sampling was not biased by proximity to forest-clearcut edge, replicate stands were a minimum of 30 ha in size. Using a geographic information system (GIS), surveyed stands were systematically chosen from a pool of stands fitting age, size, and ecosystem criteria. Systematic criteria included accessibility and geographic dispersion across the TFL. Stands greater than 1 km from vehicle access points were excluded from consideration. After applying stratified constrains to the sampling design, specific stands were randomly selected. Disturbance stands were selected non-randomly by collecting information from Janice Hodge (JCH Forest Pest Management), employees of Riverside Forest Products, and by incidentally locating stands during field operations.

Each stand was visited once during the study and, to reduce temporal bias, data collection within each landbase was spread out across the duration of this study. Each point count was surveyed for 10 minutes. Surveys were conducted from one half-hour after sunrise to one half-hour before sunset. Sampling did not occur during "poor" winter weather conditions. Generally this meant that sampling stopped when winds exceeded 15 km/hr, when daytime temperatures were below -20° C, or during heavy snowfall. A total of 492 point counts were used to sample 67 stands in the 6 landbases sampled (Table 1).

Table 1. Number of stands sampled for coarse and medium-filter non-migratory birds on TFL 49 with the mean number of point-counts conducted in each replicate (mean pts). An "x" indicates when the landbase was summarized in the coarse-filter (Coarse) or medium-filter (Medium) section of this report.

Landbase	Replicates	Mean pts	Coarse	Medium
Managed 7	12	7.7	x	x
Managed 16	13	7.9	x	x
Managed 23	12	8.0	x	
Deciduous	10	6.5	x	
Park	8	7.9	x	
Disturbance	12	6.1	x	x
High volume	10	6.3		x
Low volume	10	6.1		x
Clearcut	8	6.0		x

Data collected for each animal included species, distance from the point-count station, number of birds per flock, and activity at detection. Each animal was only recorded a single time at every point-count station and only once at every replicate when observers were sure the animal had already been enumerated (e.g., pileated woodpecker drumming). Groups of birds were treated as one observation, therefore, distance at detection was only recorded a single time for each species within a group.

Analyses

Species richness is expressed as the total number of species detected in each sampling unit. As this index is sensitive to sampling effort, we calculated total and mean species richness using 6 point-counts per replicate. We removed the 7^{th} and 8^{th} point-count from replicates when the total number exceeded 6. The relative abundance of each species was calculated as a mean of all sampled stands in each landbase. Relative abundance estimates were corrected for the distance at detection sampling bias associated with different habitats and species. Eighty percent of small birds (chickadees, golden-crowned kinglets, and brown creepers) in the managed landbase and park were detected within 40 m of the observer. This increased to 50 m in the disturbance and deciduous landbase. However, we did not detect a habitat bias for large birds (e.g., red-breasted nuthatch, crossbills, Clark's nutcracker, and three-toed woodpeckers). Eighty percent of all large bird detections were observed within 80 m of the observer.

To correct for the detection rates that exhibit a zero-inflated distribution, data for all species (with exception of the boreal chickadee) were log transformed. Boreal chickadee data was square root transformed. Means and 90 % confidence intervals (90% CI) were converted back to the original scale following Krebs (1989). To compare the similarity of bird communities between sampling units, the Renkonen Percent Similarity Index was used (Renkonen 1938, cited in Krebs 1989). If two communities have exactly the same species in the same abundance then percent similarity = 100, if none of the species are the same then percent similarity = 0. Birds not detected in the stand boundaries were excluded from all analyses. Relative abundance was not calculated for species with a small number of detections (e.g., barred owl and black-backed woodpecker). Although deciduous, park, and disturbance landbases were located in both ecosystem 7 and 16 they were not stratified by ecosystem for analyses. Eight of 10 deciduous stands, 4 of 8 park stands, and 9 of 12 disturbance stands were located in ecosystem 7.

Medium filter non-migratory birds

Defining partial retention

Alternative forms of silviculture have been increasingly used with the goal of maximizing timber supply while concurrently enhancing both the social and biological value of managed forests. These alternative silvicultural systems, defined here as partial logging or partial retention logging, are broad terms used to describe systems that leave forest structure behind. Some examples of different retention systems include: shelterwood systems, which retain trees to improve seedling survival; seed-trees systems that leave live trees to act as seed sources; diameter-limit logging, which typically remove trees with the highest market values; and green-tree retention systems which generally leave structure behind to benefit wildlife.

The partial-retention stands dealt with in this study generally have structure evenly dispersed throughout the logged area. Retention in these stands was primarily intended to meet ungulate winter range requirements.

Study design

This study compared the community similarity and relative abundance of non-migratory birds in 6 sampling units on TFL 49: the managed landbase in ecosystems 7 and 16, disturbance, high volume retention (HV), low volume retention (LV), and clearcuts (CC). Ecosystems, the managed landbase, and disturbance stands are defined in the *Coarse-filter* section of this report. We refer to unharvested stands in the managed landbase as control stands and compare them to logged stands. Similarly, we included disturbance stands as a comparison against which logged stands could be assessed. We included the disturbance stands because logged stands are often assumed to either structurally or biologically “mimic” natural disturbance. The harvested sampling units were logged between 4 and 12 years ago. We assumed that 4 years is the minimum time needed for vegetation to recover from the mechanical influence of logging and to adjust to newly created habitat conditions. We defined dispersed retention as logged stands where the retained structure is evenly dispersed throughout the block. Residual structure was generally mature Douglas-fir trees. We used residual basal area to define the low volume vs. high volume retention treatments; HV treatments ranged from 10 to 30 m^2/ha, LV treatments ranged from 1.5 to 10 m^2/ha, and clearcut treatments had less than 1.5 m^2/ha. The managed landbase generally ranged from 125 to 300 m^2/ha. Although disturbance, HV, LV, and CC sampling units were located in both ecosystems 7 and 16 they were not stratified by ecosystem for analyses. This is because we assumed that the disturbance factor would override any influence from the individual ecosystems. Nine of 12 disturbance stands, 7 of 10 HV stands, 7 of 10 LV stands, and 4 of 8 CC stands were located in ecosystem 7. GIS mapping, satellite imagery, and silvicultural prescriptions were used to identify a pool of harvested stands from which sampled sites were selected.

A total of 440 point counts were used to sample 65 stands in the 6 medium-filter sampling units (Table 1). The overstory canopy in dispersed retention sites ranged from 117 to 220 years old. Stands were sampled from January 12th to February 25th, 2003.

Remaining sampling, point-count and data collection methodologies are described in the *coarse-filter* section of this report.

Analyses

Generally, analyses follow those detailed in the *coarse-filter* section of this report. Again, relative abundance estimates were examined for any distance-at-detection sampling bias associated with habitat and species. Similar to the managed and park landbase, 80% of small birds (chickadees, golden-crowned kinglets, and brown creepers) in the HV sites were detected within 40 m of the observer. We did not detect any habitat bias for large birds (e.g., red-breasted nuthatch, crossbills, Clark's nutcracker, and three-toed woodpeckers). Eighty percent of all large bird detections in the managed, park, and HV sites were detected within 80 m of the observer. LV and CC sites had too little data to reliably estimate these biases. We therefore assumed that detection probabilities were the same as HV stands.

RESULTS

We detected 30 species of birds in the terrestrial landbase of TFL 49 (Table 2). Red-breasted nuthatch and red crossbills were the most commonly encountered species with 217 and 106 detections, respectively.

Table 2. Species detected on the terrestrial landbase of TFL 49 during the winter of 2003.

Common Name	Scientific Name
Barred Owl	*Strix varia*
Black-backed Woodpecker	*Picoides arcticus*
Black-capped Chickadee	*Parus atricapillus*
Boreal Chickadee	*Parus hudsonicus*
Bohemian Waxwing	*Bombycilla garrulus*
Brown Creeper	*Certhia americana*
Cedar Waxwing	*Bombycilla cedrorum*
Clark's Nutcracker	*Nucifraga columbiana*
Common Raven	*Corvus corax*
Common Redpoll	*Carduelis flammea*
Golden-crowned Kinglet	*Regulus satrapa*
Great Gray Owl	*Strix nebulosa*
Gray Jay	*Perisoreus canadensis*
Hairy Woodpecker	*Picoides villosus*
Mountain Chickadee	*Parus gambeli*
Northern Goshawk	*Accipiter gentilis*
Northern Pygmy-Owl	*Glaucidium gnoma*
Pine Grosbeak	*Pinicola enucleator*
Pine Siskin	*Carduelis pinus*
Pileated Woodpecker	*Dryocopus pileatus*
Red-breasted Nuthatch	*Sitta canadensis*
Red Crossbill	*Loxia curvirostra*
Ruffed Grouse	*Bonasa umbellus*
Northern Saw-whet Owl	*Aegolius acadicus*
Steller's Jay	*nocitta stelleri*
Townsend's Solitaire	*Myadestes townsendi*
Three-toed Woodpecker	*Picoides tridactylus*
Varied Thrush	*Ixoreus naevius*
Winter Wren	*Troglodytes troglodytes*
White-winged Crossbill	*Loxia leucoptera*

Total species richness varied from 3 in the clearcuts to 20 in the disturbance stands (Figure 1). The mean number of species detected per landbase ranged from a low of 0.5 in clearcut stands to a high of 5.5 in the deciduous landbase. In the standard landbase, the mean number of species detected per replicate declined from 4.8 in ecosystem 7 to 2.6 in the ecosystem

23. High volume retention stands, with a total of 16 and an average of 4.7 species per replicate, were comparable to the standard 7, deciduous, and disturbed landbases. The mean number of species using low volume and CC stands was consistently lower than all other treatments.

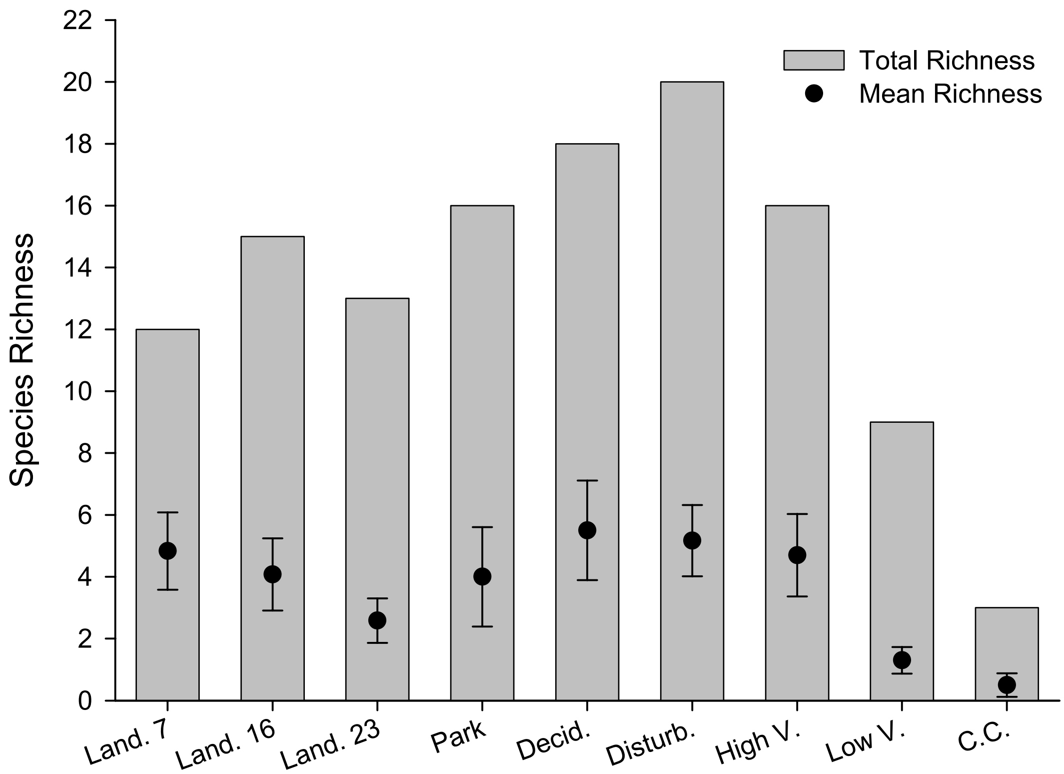

Figure 1. Total and mean number (2SE) of non-migratory bird species detected in upland and riparian habitat during the winter (January-February) of 2003.

Coarse-filter non-migratory birds

Seventeen of the species observed in this study were detected with enough frequency to permit estimates of relative abundance between sampling units. Percent community similarity ranged from a low of 62% between landbase 23 and the park to a high of 83% between landbase 7 and disturbance stands (Figure 2). The deciduous, park, and disturbance landbases were consistently more similar to landbase 7 than to landbases 16 or 23. The community similarity between landbase 7 and the deciduous, disturbance, and park landbases was 76%, 83%, and 77% respectively; similarity to landbase 16 was 64%, 74%, 68%.

Most species showed a difference in the number of detections between sampling units (Figure 2). Hairy woodpeckers and pileated woodpeckers were most abundant in landbase 7, while three-toed woodpeckers, white-winged crossbills, and pine grosbeaks were most abundant in landbase 16. Boreal chickadees were most abundant in landbase 23, however, they were detected in the park landbase with nearly the same frequency. Pine siskins, black-capped chickadees, and common redpolls were most abundant in the deciduous landbase. Relative abundance with 90% confidence intervals is presented for the 10 most abundant species in this study (Figure 3).

Black-capped chickadees were clearly most abundant in the deciduous landbase while mountain chickadees were more abundant in all landbases except 23 (Figure 3a, b). Boreal chickadees were primarily detected in landbase 23 and the disturbance landbase (Figure 3c). Brown creepers were most abundant in landbase 7 and deciduous stands (Figure 3d). Although relatively common in most of the landbases, pine grosbeaks were most abundant in landbase 16. Red-breasted nuthatches, like mountain chickadees, were abundant in all treatments except 23 (Figure 3f). Red crossbills were twice as abundant in landbase 7 than any other and nearly absent from landbase 23, while white-winged crossbills were twice as abundant in landbase 16 than any other and absent from ecosystem 23 and the park (Figures 3g, h). Except for being in low abundance in landbase 16, Clark's nutcracker showed few trends (Figure 3i). Pileated woodpeckers were absent from landbases 16 and 23, and at least 3 times more abundant in landbase 7 than any other (Figure 3k). Finally, three-toed woodpeckers were primarily found in landbases 7 and 16 (Figure 3l).

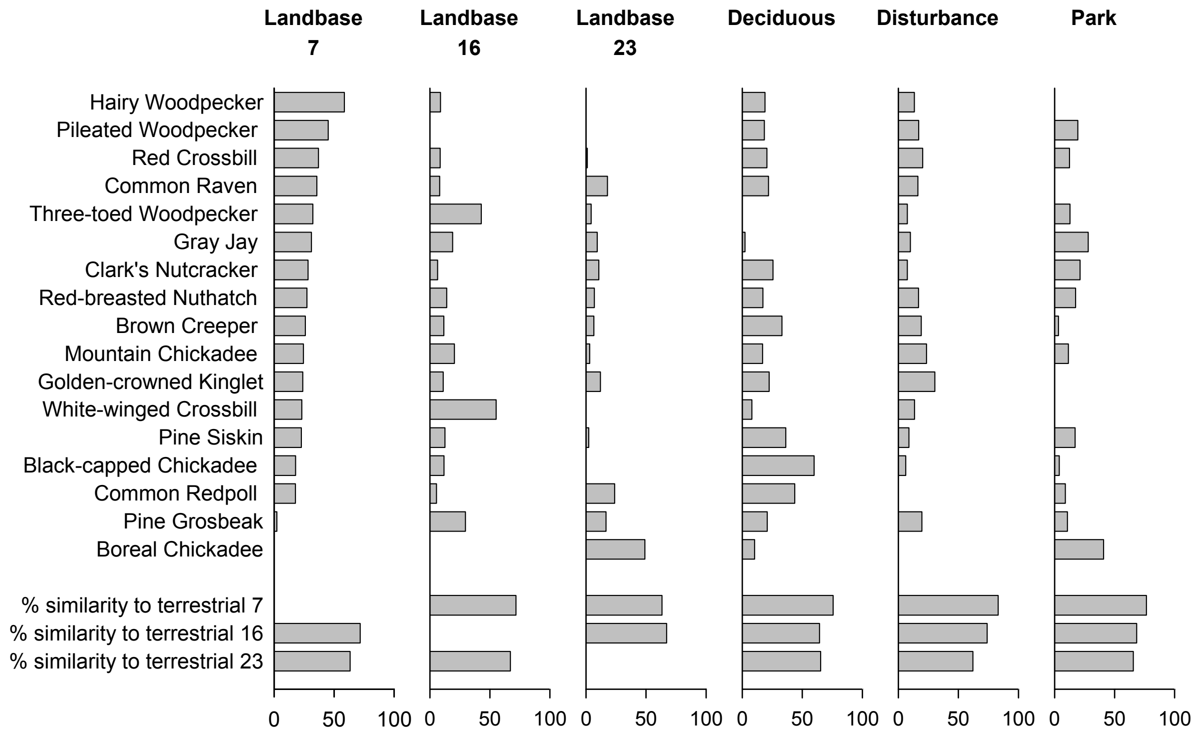

Figure 2. Relative abundance and percent community similarity of common bird species in TFL 49 during the winter (January-February) of 2003. For individual species, bars represent the percent of detections in each landbase.

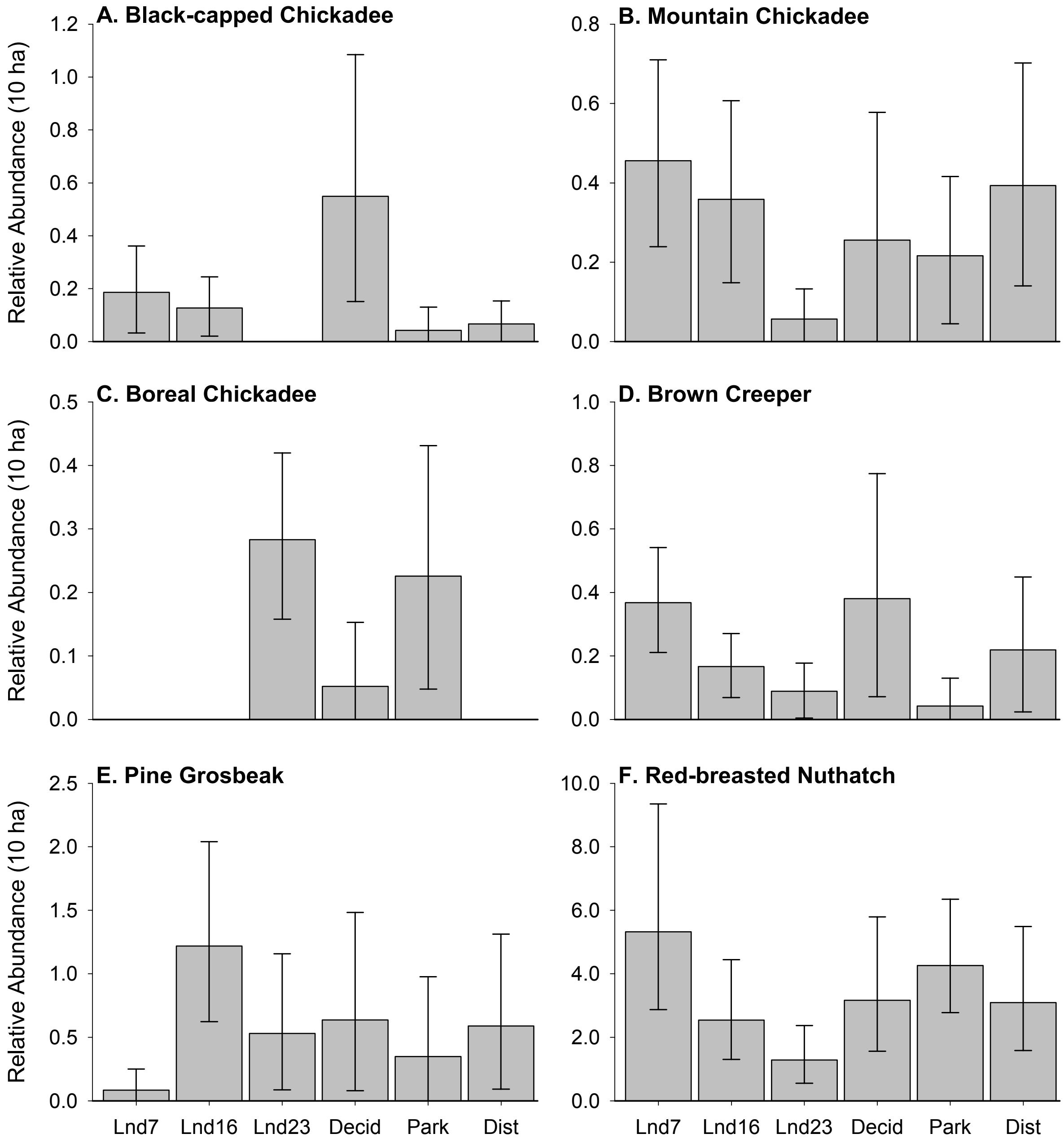

Figure 3. Relative abundance (90% CI) of non-migratory bird species in landbases 7 (Lnd7), 16 (Lnd16), 23 (Lnd23), deciduous (Decid), park, and disturbance (Dist). All sampling took place on TFL 49 during the winter (January-February) of 2003.

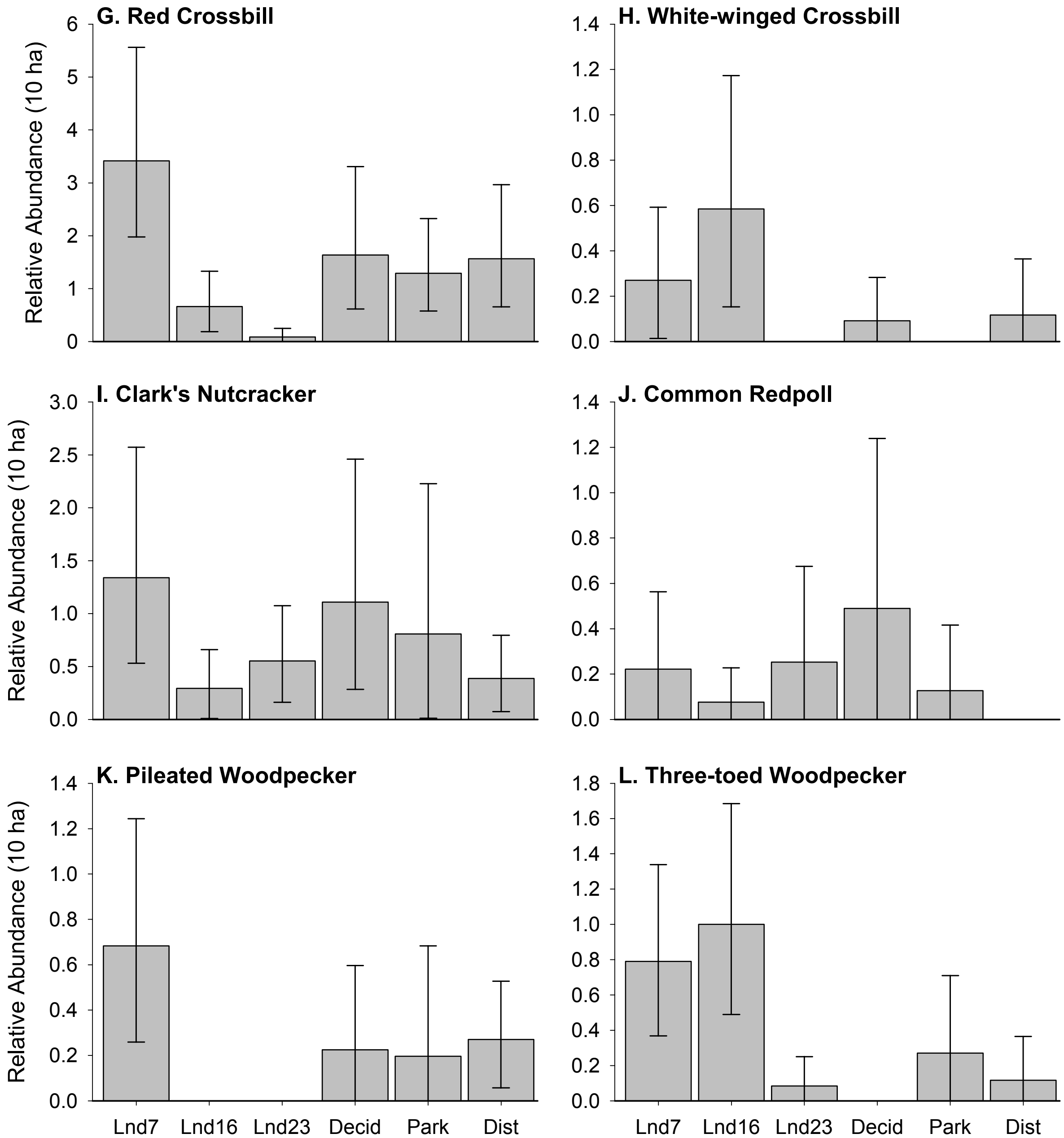

Figure 3 continued. Relative abundance (90% CI) of non-migratory bird species in landbases 7 (Lnd7), 16 (Lnd16), 23 (Lnd23), deciduous (Decid), park, and disturbance (Dist). All sampling took place on TFL 49 during the winter (January-February) of 2003.

Medium-filter non-migratory birds

Sixteen of the species observed in this part of our study were detected with enough frequency to permit estimates of relative abundance between sampling units. Percent community similarity ranged from a low of 5% between landbase 7 and CC stands to a high of 86% between landbase 7 and HV stands (Figure 4). Community similarity was 70% between landbase 16 and HV stands.

The abundance of birds clearly differed between sampling units (Figure 4). Common redpolls and Clark's nutcracker were found primarily in landbase 7. Again, three-toed woodpeckers, white-winged crossbills, and pine grosbeaks were most abundant in landbase 16. Golden-crowned kinglets were most frequently detected in disturbance stands. Unlike landbase 7, 16, and disturbance stands, no single species seemed to be particularly abundant in any of the partial harvesting stands. With the exception of three-toed woodpeckers, all the species detected in landbase 7 were detected in HV stands, although at consistently lower abundances. Overall, average winter bird abundance was 3.3 and 1.8 times higher in landbase 7 and 16, respectively, than was found in the HV landbase. Generally, LV and CC stands had fewer birds.

Relative abundance with 90% confidence intervals are presented for the 10 most abundant species in this study (Figure 5). Black-capped chickadees were least abundant in LV stands, while mountain chickadees declined in abundance in HV, LV, and CC stands (Figure 5a, b). Pine grosbeaks were more than 7 times more abundant in landbase 16 than in HV, LV, or CC stands (Figure 5c). Brown creepers were most abundant in landbase 7 and detected with approximately equal frequency in landbase 16, disturbance, and HV stands; however, brown creepers were not detected in either the LV or CC stands (Figure 5d). Golden-crowned kinglets were most abundant in disturbance stands and absent from LV and CC stands (Figure 5e). Red-breasted nuthatches declined from 5.3 detections/10 ha in landbase 7, to 2.5 in landbase 16, to 1.3 in HV stands (Figure 5f). Red crossbills were most abundant in ecosystem 7, equally abundant in landbase 16 and HV stands, and absent from LV and CC stands (Figure 5g). White-winged crossbills were most abundant in ecosystem 16 and absent from LV and CC stands (Figure 5h). Although Clark's nutcracker was had its highest abundance in ecosystem 7, it was about equally abundant in ecosystem 16, disease, and HV stands (Figure 5i). Common redpolls were equally abundant in landbase 16 and HV stands but absent from disturbance, LV, and CC stands (Figure 5j). Pileated woodpeckers were most abundant in landbase 7, absent from landbase 16, and in approximately equal abundance in disturbance, HV, and LV stands (Figure 5k). Finally, three-toed woodpeckers were most abundant in ecosystem 7 and 16, and had relatively low abundance in disturbance stands; they were absent from all partial harvesting treatments (Figure 5l). Compared to landbase 7, birds were generally less abundant in HV stands, but in most instances they were more abundant than in CC or LV stands. Winter birds were either less abundant or absent from LV and CC stands.

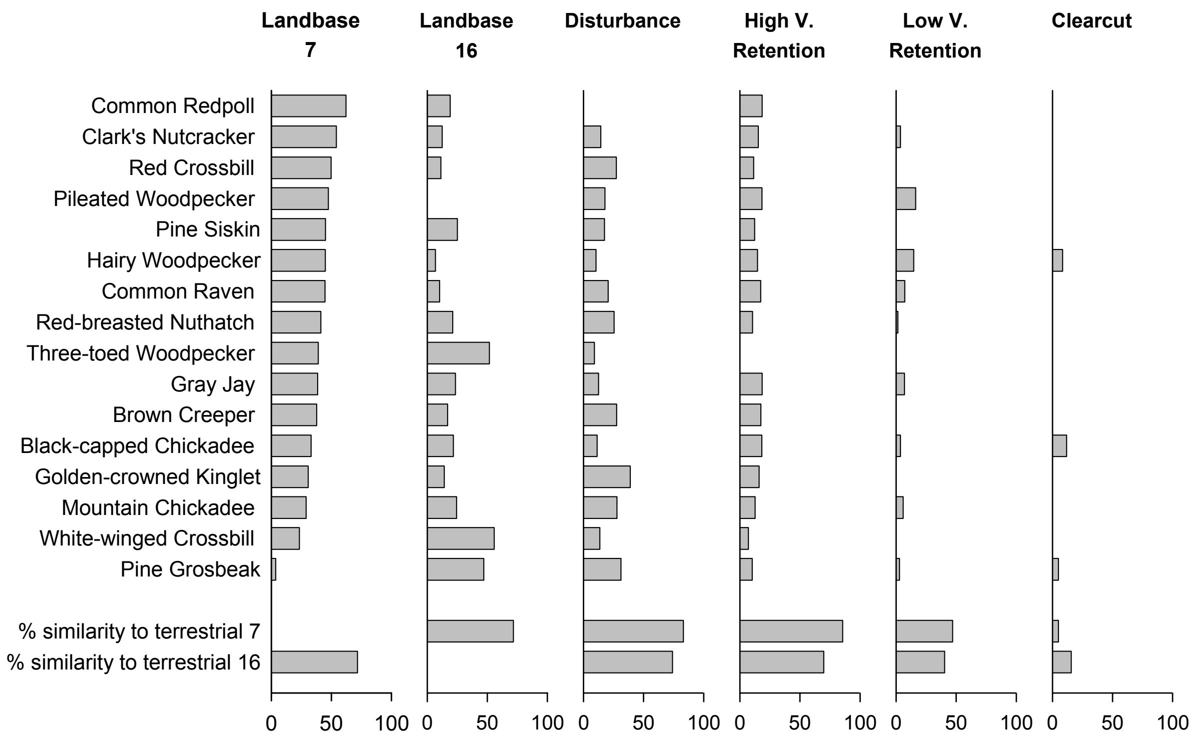

Figure 4. Relative abundance and percent similarity of common bird species in TFL 49 during the winter (January-February) of 2003. For individual species, bars represent the proportion of detections in each landbase.

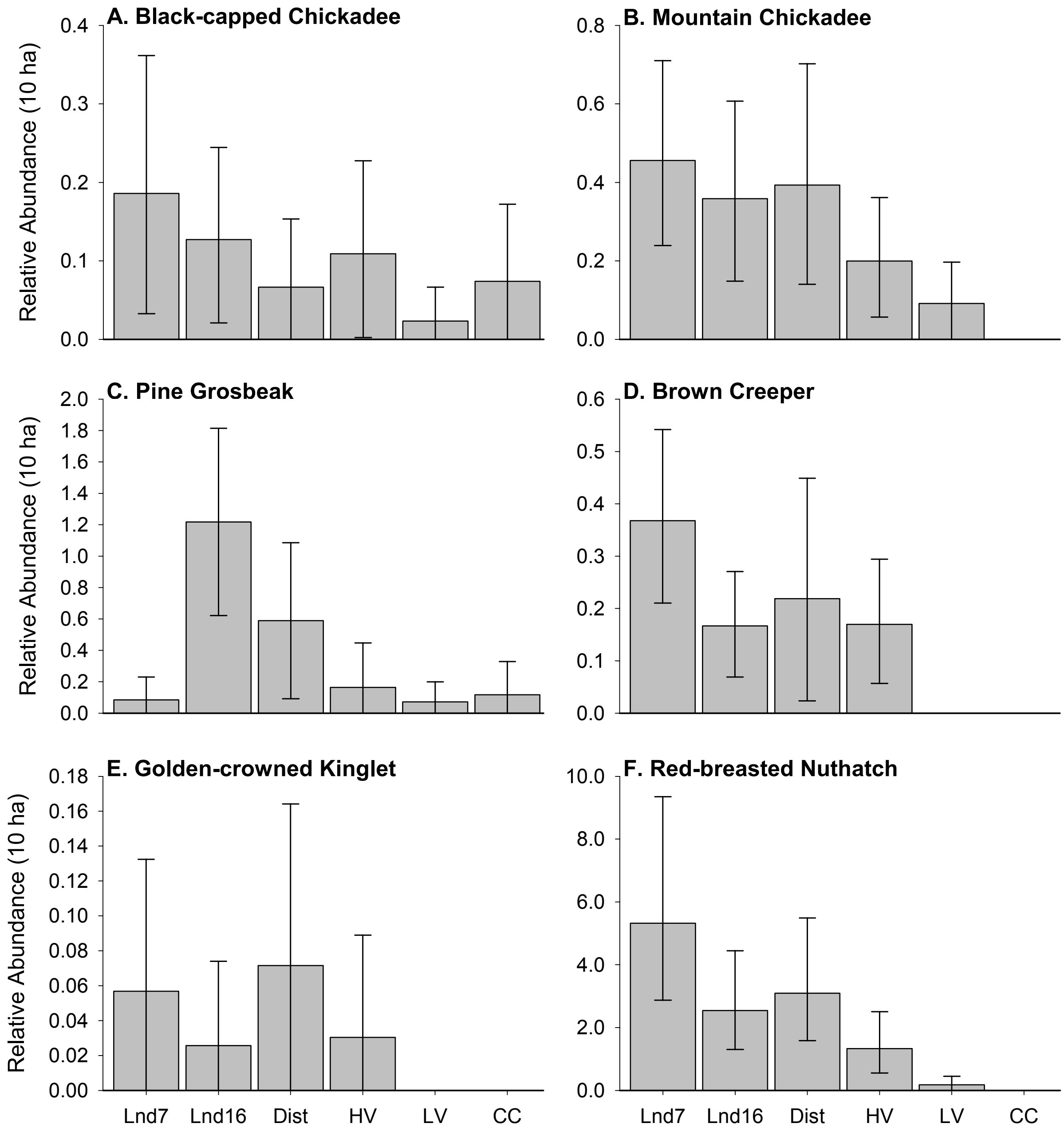

Figure 5. Relative abundance (90% CI) of non-migratory bird species in landbases 7 (Lnd7), 16 (Lnd16), disturbance (Dist), high volume retention (HV), low volume retention (LV), and clearcuts (CC). All sampling took place on TFL 49 during the winter (January-February) of 2003.

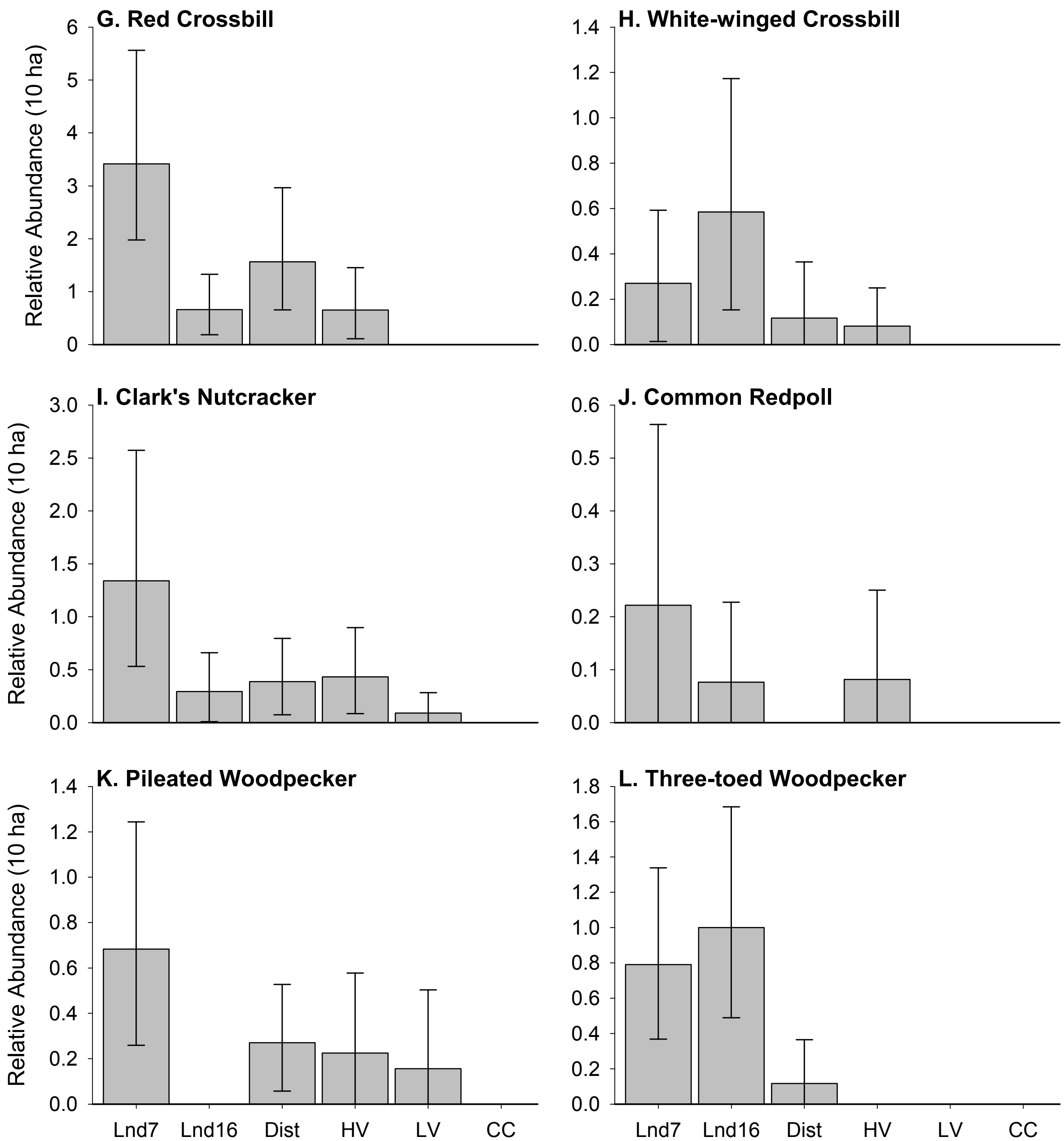

Figure 5 continued. Relative abundance (90% CI) of non-migratory bird species in landbases 7 (Lnd7), 16 (Lnd16), disturbance (Dist), high volume retention (HV), low volume retention (LV), and clearcuts (CC). All sampling took place on TFL 49 during the winter (January-February) of 2003.

DISCUSSION

Coarse filter non-migratory birds

We had five overall objectives for examining winter birds in the context of a coarse filter in TFL 49. First, we tested the park for its contribution to the ecological representation of ecosystems 7 and 16. Second, we examined the deciduous and disease landbase for their ability to make strategic contributions to ecological representation in TFL 49. Third, we established baseline estimates for winter resident birds in the three largest ecosystems (7, 16, 23) in TFL 49. Fourth, we tested the efficacy of using winter birds as indicators forest management practices in a long-term monitoring program. Finally, we identified specific species that will likely serve as good indicators of forest management in TFL 49.

Generally, the park landbase in TFL 49 appears to be doing a good job of representing the winter bird communities or ecosystems 7 and 16. The bird community composition observed in the park is most similar to ecosystem 7 followed by ecosystem 16. Further, the relative abundance of some species was comparable between the park and, landbase 7 and 16, such as the gray-jay, Clark's nutcracker, red-breasted nuthatch and mountain chickadees. There were several species, however, that were lower in the park than in landbase 7 and 16. The relative abundance of three-toed woodpeckers and brown creepers was 66% and 83% lower, respectively, in the park. Four species were absent from the park: common ravens, hairy woodpeckers, golden-crowned kinglets, and white-winged crossbills. In ecosystem 7, Herbers and Serrouya (2003) report that live tree and snag densities were approximately 50% lower in the park than the standard landbase. This overall low stem density may explain the lower relative abundance recorded for these four species. The species with lower abundance depend on the availability of snags for roosting and foraging, as well as live trees for seed productivity. The lower abundance of these habitat elements may reduce the habitat quality in the park for species that depend on these resources.

Landbases 7 and 16 showed high community similarity with both the deciduous and disturbance landbases. Mountain chickadees, brown creepers, red-breasted nuthatches, red crossbills, and Clark's nutcrackers were nearly as abundant or more abundant in deciduous and disturbance stands as they were in landbase 7 and 16 stands. Further, the deciduous landbase seems to be particularly good habitat for several species that are less abundant in the standard landbase. Black-capped chickadees, pine siskins, and common redpolls have their highest abundance in deciduous stands. Again, however, the mean relative abundance of three-toed woodpeckers in deciduous and disease stands was only 10% of their relative abundance in landbase 7 and 16. In ecosystems 7 and 16, Herbers and Serrouya (2003) show that total live tree and snag densities were approximately 50% lower in deciduous and root disease stands when compared to the standard landbase. Similar to the park landbase, this suggests that the deciduous and disease landbases examined in this study may not be doing an effective job of representing all the ecosystem functions of the standard landbase.

Of the landbases that we examined, landbase 23 had the most distinct winter bird community in TFL 49. Mean species richness was lower than in any other coarse-filter landbase examined. In addition, the relative abundance of most bird species was considerably lower in landbase 23 than in any other landbase. The most obvious exception to this trend was boreal chickadees. Boreal chickadees were common only in landbase 23 and the park. Where the range of the boreal chickadee overlaps with other chickadee species, it is always found at higher elevations (Ficken et al. 1996), therefore, the distribution of the boreal chickadee in ecosystem 23 is consistent with other studies.

Three-toed woodpeckers are not yet a conservation concern in Canada and are not likely to become one in the near future. However, they may serve as indicators of specific ecosystem functions. Three-toed woodpeckers feed almost exclusively on standing and recently dead conifer trees, scaling for bark and wood-boring beetles (Villard 1994; Hutto 1995; Kreisel and Stein 1999). As a result, they are often found in recently burned stands that have high densities of dying and recently dead trees (Villard 1994; Hutto 1995; Kreisel and Stein 1999). Three-toed woodpeckers may be good indicators for species (known or unknown) that depend on similar structural characteristics.

We found that three-toed woodpeckers were lower in abundance in park, deciduous, and disease landbases; landbases that also had a low density of live and dead trees. As a result, coarse and medium-filter strategies that focus on the creating conifer stands with a density comparable to landbases 7 and 16 might be given priority. These types of stands might simply be created by lengthening rotation ages on a portion of the partially constrained landbase.

Despite being a critical time of year for non-migratory birds in Canada, winter bird sampling is not commonly conducted. This type of work is avoided primarily because of low detections and logistical difficulties. Winter resident birds often flock during the winter months and tend not to sing or call with the same intensity as they do during the breeding season. As a result, it is more difficult to census winter bird populations. This, coupled with the difficulties of conducting field work during the winter, has restricted the number of winter studies that have been conducted. We found that, with moderate effort, good estimates of relative abundance could be generated for species such as the chickadees, brown creepers, red-breasted nuthatchs, red crossbills, and three-toed woodpeckers. These species could form a component of a longer-term monitoring program. Estimates of relative abundance could be improved by narrowing the study question and focusing sampling effort in fewer stands.

Conclusion

The park landbase appears to be doing a good job of ecological representation of ecosystems 7 and 16. In particular, species such as pileated woodpeckers, gray jays, Clark’s nutcracker, red-breasted nuthatch, and pine siskins appear to be common. Similarly, deciduous and disease landbases might make significant contributions to a strategic coarse-filter strategy for maintaining biological diversity. Specifically, the abundance brown creepers, red crossbills, pileated woodpeckers, mountain chickadees, black-capped chickadees, and pine grosbeaks suggest that large components of the biodiversity in TFL 49 will benefit from the retention of these stands in an unmanaged condition.

The results reported in this document were collected on a single group of species, in a single year, during a single season. These results should, therefore, be considered a starting point from which questions and future study designs could be further refined. Although some of the results are compelling, they should be further examined to ensure that they are robust to different species groups in different seasons.

Medium filter non-migratory birds

Species richness and community composition in high volume retention stands was similar to both landbase 7 and 16. The three-toed woodpecker was the only species found in ecosystem 7 that was not found in high-volume retention sites. The pileated woodpecker, although absent from landbase 16, was present in HV retention stands. In contrast to HV stands, neither LV retention stands nor clearcut stands provided effective habitat for non-migratory bird species during the winter months. Given that most non-migratory birds species are typically associated with forest structure such as live trees and snags, this finding is not surprising. Our results are consistent with previous research. Species richness and community composition of bird species in partially harvested stands become increasingly similar to unharvested forests when more residual trees and snags are maintained (e.g., Norton and Hannon 1997; Steventon et al. 1998; Chambers et al. 1999; Schieck and Hobson 2000). LV retention stands are most similar to clearcut stands in terms of species richness, composition and abundance (e.g., Steventon et al. 1998; Chambers et al. 1999). Although HV stands clearly provide substantially more habitat for a range of non-migratory bird species, average bird abundances in landbase 7 and 16 was consistently higher (respectively 3.3 and 1.8 times) than in HV stands. This suggests that important resources, such as foraging or roosting requirements, were not as common in the HV retention sites, thus resulting in lower species abundance. However, if the goal of management is to maintain habitat for specific forest-dwelling bird species, the HV retention stands are clearly more effective than LV or clearcut stands at achieving this goal.

Aside from comparisons with mature unharvested forest, a practical comparison to HV stands is the natural disturbance landbase. Besides fire, finer-scale disturbances such as *armillaria* and bark beetle-infected stands are an appropriate comparison to HV retention sites in TFL 49. These fine-scale disturbances decrease the density of live trees, increase the density of snags, and create gaps in the overstorey. However, Herbers and Serrouya (2003) found few structural similarities between naturally disturbed and HV stands. Live tree, snag, and CWD densities were all lower in HV stands when compared to root disease stands. In this study we found that most non-migratory bird species were also less abundant in HV stands. Further, three-toed woodpeckers were absent from all partial harvesting treatments. As a result, we suggest that HV stands, rather than being designed solely to approximate natural disturbance, be used as a specific medium-filter planning tool to enhance habitat attributes that are difficult to maintain in the intensively managed landbase.

Generally, HV stands appear to be a good strategy for maintaining or enhancing the habitat quality for many species including forest birds that depend on live trees and CWD. Species such as pileated woodpeckers, brown creepers, mountain chickadees, and pine grosbeaks appear to consistently use HV stands during the winter. This indicates that other groups of species that depend on live trees and CWD may continue to utilize HV stands. For example, Herbers (2001) found that red squirrel density in HV retention Douglas fir stands declined in direct proportion to the volume of timber removed. Although there were behavioural shifts in red squirrels living in HV stands, survival and reproductive success were not affected. HV stands in TFL 49 have the potential to make targeted contributions toward maintaining short and long-term ecological sustainability on TFL 49.

We examined the response of winter-resident birds to recently created partially harvested stands. It is likely that these stands will become more effective at meeting biodiversity objectives with age. For example, Imbeau et al.

(1999) found bird communities began to converge 30 years post-disturbance between fire created and logged stands in black spruce forests of eastern North America. Further, bird communities in these stands also became more similar to mature forest. While the time scale may be different in southern interior ecosystems, residual retention in harvested stands will increase the habitat heterogeneity of the forest as it grows, providing old growth-like characteristics in second-growth stands. This will almost certainly enhance the quality of this habitat for most forest-dwelling species earlier than typical second-growth stands.

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