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Impacts of partial harvest of riparian buffer strips on cavity and bark-nesting birds in boreal mixedwood forest

Highlights

- Typically, buffer strips of uncut forest are left after harvest along lakes and streams; however, some forest companies are now harvesting some of these trees to approximate effects of wildfires that burn to the edges of water bodies.
- Bird species that nest in cavities are often resident species that require older forest structures year-round, and, hence, are sensitive to forest loss. Forest managers may be able to use declines in this group to indicate excessive forest loss.
- We measured the response of cavity-using communities to three levels of tree retention (low (0-33%), medium (34-66%) and high (>66%)) in riparian buffer strips of old aspen-white spruce mixedwood.
- Comparing across the three retention levels, the biggest changes in communities were in sites with less than 33% forest retention.
- By describing the habitat features where three focal species had moderate to high occurrences, we determined a range of habitat conditions that we predicted would encompass the members of the cavity-using community that use older forest.

Traditional clearcutting systems in Canada's boreal forests have reduced the amount and structural variability of older forest stands and increased forest fragmentation. These landscape alterations have reduced abundance of some forest birds as their habitat decreases. To reduce the negative effects of harvest on wildlife, some companies have begun to harvest in a way that approximates patterns and structures left after natural disturbances.

Treed riparian areas and forest management

In forests across North America, many provincial and state agencies require the retention of intact forest strips or buffers along the edges of water bodies in harvested landscapes. Buffers can function to reduce upland run-off and maintain water quality, and to conserve fish stocks, insect communities and near-shore vegetation. In addition, they are a source of old forest habitat, suitable for some old-growth dependent species. Retaining intact buffers, however, is inconsistent with a natural disturbance model since fire can burn to the edge of a water body. Other natural processes, such as removal of trees by beaver or blow-down by wind, can also remove a certain proportion of trees in riparian areas.

To approximate the tree composition and structure of forest left by natural disturbances in riparian buffers, partial-harvesting in buffers may be more appropriate (i.e. removal of a certain percentage

of trees within buffers). Recently, some companies operating in the Boreal Plains ecozone have experimented with harvesting buffers and retaining variable amounts of forest as strips, patches, and individual trees within harvest blocks. Depending on the size, abundance, spatial pattern, and/or composition of these residual structures, this harvest approach may retain suitable habitat in buffers for birds or may reduce or eliminate usable riparian forest habitat. The effect of partial-harvesting in buffers on avian communities, as with many faunal groups in the Boreal Plains ecozone, remains relatively untested and represents a knowledge gap in forest management.

The importance of scale in forest management

Historically, most studies have looked at the use of forest patches (including buffers) by birds in harvested landscapes at the stand level only. However, forest management affects both stand and landscape scales, and changes across the landscape may influence local-scale bird-habitat relationships. Birds with territories that extend beyond the buffer may be influenced by habitat features surrounding the buffer. Similarly, landscape elements such as water bodies and forest patches could be either dispersal barriers or serve as corridors into a buffer, depending on the species. Avian responses to habitat at various spatial scales should be determined and forest planners may need to consider habitat features at the scale with the strongest influence on bird communities or individual species. A common approach in management studies is to sample individuals within a habitat patch and relate species occurrence or abundance to surrounding habitat features at multiple spatial scales. This multi-scale method identifies the relative influence of patch vs. landscape-scale habitat on local birds, and can provide forest managers with recommendations across multiple spatial scales.

A primer on cavity/bark nesting communities

Many species that produce nest cavities or nest under the bark of trees are resident species (i.e. they live year-round in the forest) and many use elements of older forest, including large live decaying trees, snags, and downed woody material, for nesting or foraging. Hence, these species may be particularly sensitive to loss of older forest. The interactions between species in the cavity-using community can be described in a "cavity nest web".

Key features of the nest web include tree species used predominantly for nest cavities and species with other important ecological roles, such as keystone excavators (species whose cavities are used at a rate higher than expected based on their abundance) or dominant excavators (those who excavate the majority of cavities available in the web). Secondary users are the species that use the cavities of the primary excavators (Figure 1). Weak excavators dig their own cavities in soft or rotting wood. In the western boreal mixedwood, the most important tree species for cavity excavation is aspen and the most important primary excavators are Yellow-bellied Sapsuckers, Northern Flickers and

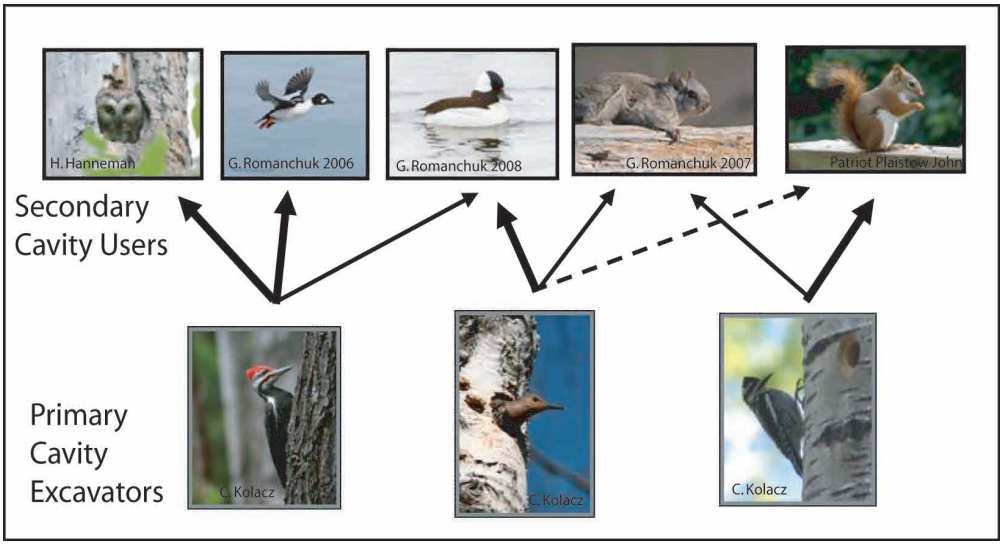

Figure 1. Example of key interactions in an aspen cavity-using community. Thicker lines represent a greater proportion of cavity re-use by species. Diagram reproduced with the permission of Hilary Cooke.

Pileated Woodpeckers. Yellow-bellied Sapsuckers are dominant excavators and Northern Flickers and Pileated Woodpeckers are keystone excavators.

Because primary excavators perform such an important ecological role, they have been used as indicators of the integrity of the entire nest web community and as an indicator of total bird species richness. Bark nesters, such as the Brown Creeper, do not nest in cavities, but rather under the dead bark of snags or dying trees. Thus, they require similar habitat structure to older forest resident cavity nesters and can be used as indicators of old forest bird communities.

Assessing the importance of tree retention in riparian buffers

Our study determined: 1) how the cavity/bark nesting community was influenced by the degree of harvesting in riparian buffers; 2) what features within the buffer and surrounding the buffer influenced the composition of bird communities and use by three older-forest species (Yellow-bellied Sapsucker, Boreal Chickadee and Brown Creeper); and 3) whether within-buffer or landscape-scale habitat features had the strongest influence on community composition or species use of the buffer. The study was conducted in partially-harvested and intact riparian forest in old (mean age ~100 yr) aspen-dominated mixedwood in the Duck Mountain Provincial Forest (DMPF) of western Manitoba within and around Louisiana Pacific Canada Ltd.'s Forest Management Unit #13. Traditional forestry in the area left 50m uncut buffers along watercourses, but the company harvested some buffers experimentally. The amount of forest retained in each buffer varied from 4 to 100%, and we divided these into three levels of tree retention (low (0-33%), medium (34-66%) and high (>66%)). Habitat variables were measured within the buffer and within 700m of the buffer.

Influence of tree retention and other habitat variables on cavity users

First we analysed the effect of forest retention and other habitat variables at different scales on the bird community. Bird communities were influenced by habitat variables at the scale of the buffer only. The bird community was similar in medium and high retention sites, but was significantly different in low retention sites (<33% forest cover). Brown Creepers and Red-breasted Nuthatches were strongly and positively associated with high forest retention. Site use by Yellow-bellied Sapsuckers was associated with high retention of old deciduous forest, large snags, large aspen with conks and live birch trees. Boreal Chickadees were found in high retention conifer sites. Tree Swallows, an open habitat species, were found primarily in low retention sites. Other species in the web were either not common enough to analyse or were not strongly related to forest retention.

Some forest companies choose a fine-filter management approach where they select a subset of species and manage habitat for them. Species of interest are typically those negatively affected by harvesting and that meet one or more of the following three criteria: 1) they rely on old-growth forest and are sensitive to habitat loss and/or fragmentation, 2) they have declining regional abundances or 3) their activities strongly affect other species in forest ecosystems (i.e. keystone or dominant species). Based on these criteria, we chose three species that used old forest, were relatively common and had either a key ecological role (Yellow-bellied Sapsucker, a dominant excavator) or were predicted to be negatively affected by harvest (Brown Creeper, Boreal Chickadee). We analysed their habitat associations in more detail to determine the habitat features in the buffer (local scale) and around the buffer (larger scale-up to 700m away) that best predicted their occurrence. Local buffer-scale factors were most important in predicting site use for Yellow-bellied Sapsuckers and Brown Creepers, whereas site use by Boreal Chickadees was most strongly influenced by large-scale habitat features. Yellow-bellied Sapsuckers used sites with a high density of large aspen trees with conks. Boreal Chickadees were found in buffers with high conifer tree density that were surrounded by landscapes with lower proportions of harvest and wetlands and higher proportions of intact and conifer-dominated forest. Brown Creepers used sites with higher forest retention.

What can managers do?

Management for bird communities

Using a coarse-filter approach, managers attempt to maintain a range of environmental conditions at multiple scales to provide habitat for many species. Forest planners may need to consider habitat features at the scale with the strongest influence on bird communities or individual species. We found that communities were not described by habitat at medium (~25ha) and large (~210ha) spatial scales; however, this study did not sample the keystone Pileated Woodpeckers effectively because their territories exceeded the area of the sample grids. The results suggest that, at least for the smaller species in the cavity nest web, management of bird communities found in intact forest should focus on managing habitat within the buffer. If managers decide to harvest in the riparian buffer strip, then they should retain conifer trees in at least some buffers and retain large aspen trees with conks, large snags and live birch trees in others. Most cavity/bark using species found in intact buffers were also present in buffers with high (>67%) and moderate (34-66%) retention levels but were absent or scarce in low retention buffers.

Management for individual species

While managers cannot conduct fine-filter management for all species in the forest, some companies have chosen to use a fine-scale approach to try to maintain specific habitat elements to conserve one or a few species of primary interest or ecological importance. For our three focal species we noted sites where they were absent, at abundances lower than the average abundance across all sites, at average abundances and at abundances higher than average (Figure 2). What is clear from this figure is that there is a range of habitat conditions that would have to be maintained to provide habitat for all three species (i.e. don't do the same thing everywhere).

	YBSA	BOCH	BRCR			YBSA	BOCH	BRCR
Retention (% forest)					**# Large aspen trees with conks/ha**			
Low (<33)					0-5			
Medium (34-66)					5-20			
High (>66)					20-60			
Intact (100)					>60			
# Conifer trees/ha					**Mean dbh of deciduous trees >12cm dbh**			
0-20					18-21			
20-100					21-23			
100-200					23-26			
>200					26-36			

Figure 2. Relationships between Yellow-bellied Sapsucker (YBSA, n=47), Boreal Chickadee (BOCH, n=34) and Brown Creeper (BRCR n=49) abundance and habitat measured at the local (i.e. within buffer) scale. White=did not occur, light grey=lower relative abundance, dark grey=similar relative abundance and black=higher relative abundance than found on average across all sites.

Using Figure 2 , we suggest that the recommendations for communities above be supplemented with the following suggestions:

- At least 33% of forest should be retained in most buffers and some buffers should remain intact or have at least 66% of forest retained.

- In deciduous-dominated forest, a high density of large (≥ 25cm dbh) aspen trees with conks (>20 trees/ha) should be retained, with some buffers containing > 60 trees/ha for Yellow-bellied Sapsuckers and Brown Creepers.
- In conifer-dominated stands, a high density of conifer trees (≥ 12cm dbh) should be retained. In some buffers at least 100 stems/ha should be retained for Boreal Chickadees and in others at least 200 stems/ha for Brown Creepers. For these species, 5-20% of the forested area around some buffers should be coniferous.
- Around some buffers, we suggest leaving >20% of a ~200ha forested area around the buffer unharvested for Boreal Chickadees. Preferably areas around some sites should be left unharvested or retain high numbers of trees for Brown Creepers.

Uncertainties

Our results are relevant to riparian forest management in the Boreal Plains ecozone. Some uncertainty exists in how wide of a geographic area the results can be applied. In addition, we surveyed abundance of species in the breeding season and did not collect data on the breeding success or survival of birds, nor do we have information on their distribution during the winter. Studies in New Brunswick, for example, indicate that the threshold density of trees required to support nesting Brown Creepers is higher than that required for the species to be present. Thus, our recommendations may underestimate the amount of retention required for a breeding population. Our survey areas were limited to buffers and, hence, we did not adequately sample larger species, such as Pileated Woodpeckers, that have territories that range beyond our survey areas. Because of these uncertainties we suggest that companies adapt these recommendations in an "adaptive management" framework. These suggestions could be implemented, but then sites could be monitored to ensure that the desired outcomes in terms of biodiversity are reached.

Management Implications

- If managers decide to harvest in the riparian buffer strip, they should retain conifer trees in at least some buffers and retain large aspen trees with conks, large snags and live birch trees in others.
- At least 33% of forest should be retained in most buffers, and some buffers should remain intact or have at least 66% of forest retained.
- Maintaining unharvested habitat around some buffers is an important step in ensuring landscape connectivity.
- Managers should remember the importance of variability for boreal species and use an adaptive management approach for riparian buffer harvesting.

Further reading

For a more detailed description of this study, refer to:

Clarke, H. 2008. *Impacts of partial harvest of riparian buffer strips on cavity-nesting birds in boreal mixedwood forest.* M.Sc. Thesis. University of Alberta, Edmonton.

For another study on the larger songbird community use of partially harvested buffers in the same region, see:

Kardynal, K. 2007. *Responses of bird communities inhabiting boreal plain riparian habitats to forestry and fire.* M.Sc. Thesis. University of Saskatchewan, Saskatoon.

Kardynal, K.J., K. A. Hobson, S.L. Van Wilgenburg, and J. L. Morissette. 2009. *Moving riparian management guidelines towards a natural disturbance model: An example using boreal riparian and shoreline forest bird communities.* For. Ecol. Manage. 257: 54-65.

For more information on cavity nest webs and woodpeckers as indicator species see:

Drever, M.C., K.E.H. Aitken, A.R. Norris, and K. Martin. 2008. *Woodpeckers as reliable indicators of bird richness, forest health and harvest.* Bio. Conserv. 141: 624-634.

Martin, K., K.E.H. Aitken, and K.L. Wiebe. 2004. *Nest sites and nest webs for cavity-nesting communities in interior British Columbia, Canada: nest characteristics and niche partitioning.* The Condor 106: 5-19.

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