Ontario WOODLOT .com Woodland Notes

Can Forest Birds Cope in Managed Woodlots?

By: Ken A. Elliott, RPF, OMNR Science and Information Section

The following article is a summary of the presentation made by Ken Elliott at the Ontario Woodlot Association's AGM and Woodlot Conference (Belleville, Ontario, February 28, 2004).

Some bird species that winter in the tropics and breed in woodlots within southern Ontario (neotropical migrants) have recently experienced population declines. Large-scale forest loss, fragmentation, alteration of breeding habitat and changes to wintering grounds may all play a role in these declines.

The most sensitive species are those that do not cope well with the great amount of edge habitat that now exists within the Carolinian Zone's highly fragmented remnant woodland (that only covers 11% of the land). As well, this is an actively managed woodland with most woodlots experiencing at least one forest harvesting event every 30 years. If any of the forest management being practiced causes an increase in areas functioning as edge habitat, this may further degrade conditions for the most sensitive species.

The majority of woodlots are harvested based on an agreement between a logging firm and the landowner, where the choice of trees harvested depends on municipal tree conservation by-laws that set minimum tree diameters above which all trees may be removed. Managers more focused on the future usually conduct harvests under the single-tree selection system, which is well documented as the ideal system for managing upland tolerant hardwood forest ecosystems and is supported by foresters, tree markers and provincial guidelines.

This article is based on a study conducted in the Carolinian Zone of southern Ontario where vegetation, birds and amphibians were monitored in 25 upland tolerant hardwood forests. This retrospective study began in 1999. We chose harvested study sites (16 woodlots) that had been cut within the preceding five years (1994-1998). The woodlands ranged in size from 19 to 261 ha, and the sites within each treatment category contained a cross-section of these woodland sizes. Data has been collected on nine control sites, ten single-tree selection sites and six diameter-limit sites. The study was designed to provide data that would characterize how forests change immediately following harvesting under the two most common methods and to determine how this harvesting impacts forest bird populations.

When woodlot owners first enter their forest following harvesting they usually notice the increase in light and the more open feeling. This first indicator of harvesting is known as "percent crown closure." The nine control sites had an average crown closure of 95%, leaving only 5% of the canopy open for light to shine through. The standard cut sites (seven single-tree selection sites) had 85% crown closure and the heavy cut sites (six diameter-limit sites and three overcut single-tree selection sites) had 66.5% crown closure.

This openness is mostly the result of a decrease in the density of canopy trees on the harvested sites. Basal area[1] (BA) is a density measurement commonly used in describing forest ecosystems. The BA of a single tree can be calculated by taking a measurement of the tree's diameter at 1.3 m from the ground (breast height) (dbh). The BA is equal to calculating the surface area of a stump cut at this height. From our school years we can recall that the area of a circle $= \pi$ (radius)^2. The BA in m^2/ha for a plot, stand or forest is equal to the combined BA of all the trees in that location divided by the number of hectares. Average pre- and post-harvest study site BAs were calculated using diameter measurements of all the living trees and the modelled diameters for all the cut trees based on stump measurements within all the forest measurement plots.

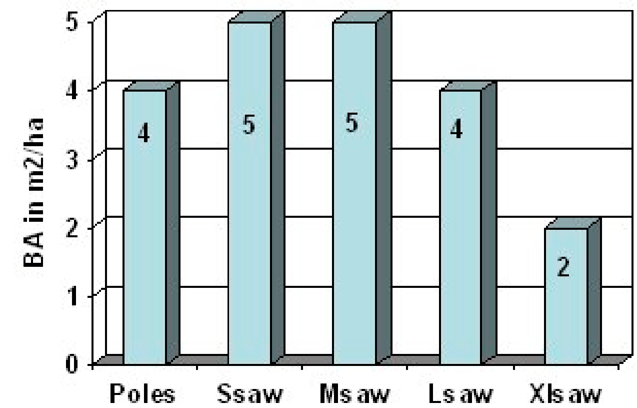

Figure 1: Recommended ideal residual stand basal area distribution across the diameter classes (poles and small, medium, large and extra-large sawlogs) for tolerant hardwood forests in the Carolinian Zone.

The change in "average total stand BA" is the second indicator of forest harvesting that we measured. The dense, dark green control sites had not been commercially harvested for 24 or more years and they had stand BAs averaging 32.4 m^2/ha (range 27.3 – 37.1 m^2/ha). The standard cut sites had an average pre-harvest BA of 26.1 m^2/ha (range 22.5 – 33.1 m^2/ha) with an average post harvest residual BA of 21.9 m^2/ha (range 19.5 – 25.6 m^2/ha). The heavy cut sites had an average pre-harvest BA of 27.9 m^2/ha (range 21.6 – 35.7 m^2/ha) with an average post-harvest residual BA of 17.5 m^2/ha (range 13.8 –22.1 m^2/ha). Harvesting has reduced the BA on the standard cut sites by 16% and by 35% on the heavy cut sites.

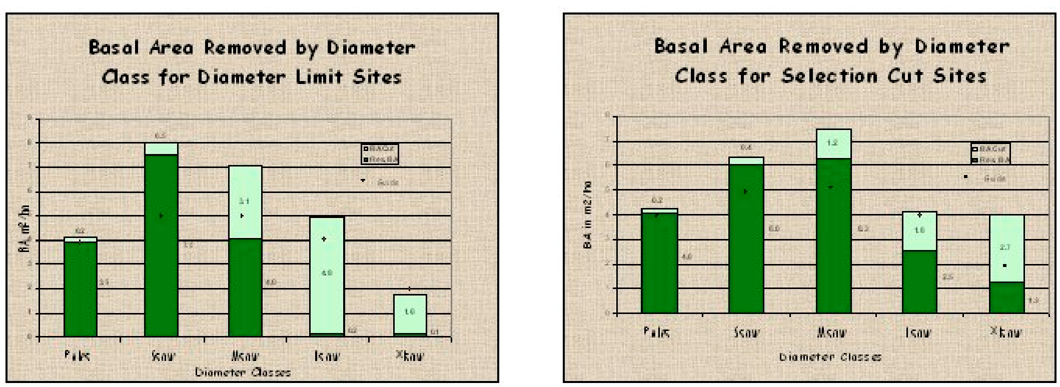

Figure 2: Basal area removed (light colour) and residual (dark colour) by diameter class for diameter limit sites (left graph) and for selection sites (right graph). The dots represent the provincial ideals portrayed in Figure 1.

A Silvicultural Guide to Managing Southern Ontario Forests (OMNR, 2000) describes single-tree selection as an all-aged or all diameter silvicultural system. It uses periodic harvesting on a ten- to 25-year cycle to remove individual trees of all ages (diameters) to reduce the stand basal area to the optimum growing BA of 20 m^2/ha (for trees 10+ cm dbh). The system is based on optimizing quality and growth and on ensuring sustainability of shade tolerant hardwoods by striving for a balanced distribution of the residual BA across the diameter classes (see Figure 1). Managers are encouraged to fully utilize the growing space by not removing more than 1/3 of the total stand BA in any single harvest.

"Stand structure" change was the third harvest indicator that we calculated. As we expected, the diameter-limit harvests targeted the removal of all the largest trees (see Figure 2). Only 5% of the basal area in trees 50cm dbh or greater was retained and 2/3 of this was in poor quality trees. As well, 43% of the medium sawlogs (38 – 48 cm dbh) were also removed. This highly degraded stand structure on the diameter-limit sites is more consistent with an even-aged stand.

Considerably less BA is removed from the selection cut sites leaving an uneven-aged stand structure that is easier to sustain (see Figure 2). However, despite original surpluses in the small and medium sawlog classes 70% of the harvest is coming from trees 50 cm dbh or more, leaving the larger size classes slightly below the provincial guideline. As well, very little attention has been paid to the thinning of the small and medium sawlog size classes.

Figure 3 clearly identifies four different stand structures that can be discussed. The control sites demonstrate an uneven-aged "old growth" stand structure with higher BAs across all the diameter classes and many large trees. In comparison, the selection system sites also have a balanced uneven-age stand structure; however, the large size classes have been left almost 50% below the provincial ideal. The diameter limit harvest truly aims to remove the large trees, leaving an even-aged stand structure.

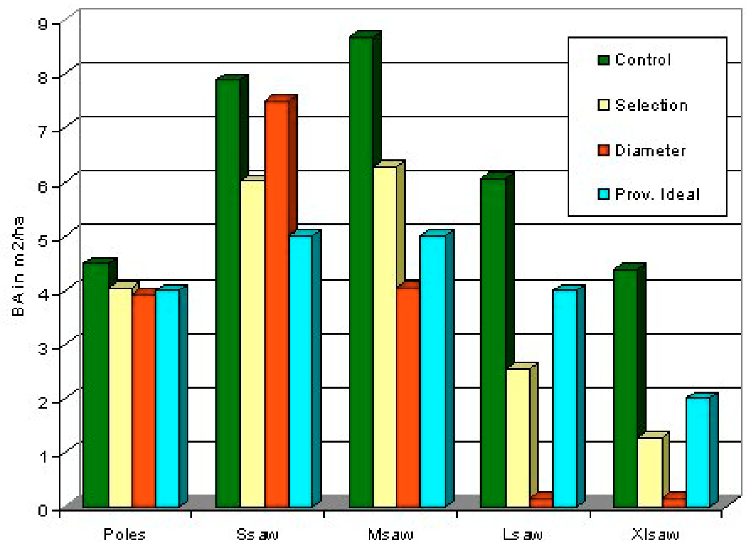

Figure 3: Distribution of residual basal area across the diameter classes based on the averages for the sites with control, single-tree selection and diameter-limit prescriptions as compared to the provincial ideal for the Carolinian Zone.

The increased light penetrating the canopy on the heavy cut sites seems to have increased the densities of woody stems in the lower strata of the forest. In the layer above 50 cm and including stems up to 2.5 cm dbh the heavy cut sites had 569 stems/ha which was 225 more than the controls and 231 more than standard cut sites. At first glance, this would appear to indicate that the heavy cut sites are actually improving conditions for tree regeneration. However, further analysis reveals that 54% of the stems in this layer are shrubs on the heavy cut sites while the percentages for the controls (37%) and standard cut (32%) sites are much lower. Most of the increase in woody stems can be attributed to an increase in shrubs such as raspberries, which compete with tree regeneration but may also form important habitat for nesting birds.

The study found the tree regeneration close to the ground, i.e., below 50 cm, to be representative of the canopy species. The canopies of our study sites are dominated by sugar maple (33 to 46% of total BA) with American beech as a consistent co-dominant at 10 to 20%. The other dominants include red oak (7%), red maple (7%), white ash (6%), green ash (4%), silver maple (4%), bitternut hickory (4%) and black cherry

(3%). The remaining 18% of the BA are made up of 35 additional woody species found in at least one plot. When we looked at the distribution of tree species in the regeneration layer we found the same 9 dominant species; however, their ranking was slightly different. The oaks were the most variable between treatments. Although the controls had the highest proportion of oaks in the canopy, the regeneration layer had the lowest numbers likely due to high shade conditions, which oaks tend to dislike. As well, in the canopy only the oak species (red and white) seemed to experience any changes to their relative proportions following harvesting. The standard cut sites reduced the oak component by 22% and the heavy cut sites showed a 29% reduction in the oak overstory. The loss of oak is likely inevitable on these tolerant hardwood sites where oak cannot be expected to be as good a natural competitor. However, harvesting focused on the oak species does seem to be accelerating this.

We found 307 non-woody plant species (281 native and 26 non-native) in the regeneration layer of our study sites. The communities of the control and standard cut sites were quite similar while the heavy cut sites, especially those with the lowest large tree BA, had the highest levels of diversity. When we did a "floristic quality" analysis we found that heavy cut sites also had a higher abundance of invasive species and generalists and a decrease in the number of conservative species. In this case the increase in biodiversity actually represents a decrease in quality.

Our data collection also looked at classifying the quality of the trees found in our plots. We found the controls to have the highest amount of total BA in good quality trees. When we looked at the A1 quality trees in the sawlog size classes we found the control sites to have 10.4 m2/ha of BA, the selection cut sites had 9.1 m2/ha and the diameter-limit sites were down to 5.6 m2/ha. As well the proportion of good quality vs. poor quality trees in the large sawlog sizes was considerably greater on the selection cut sites, with 78% acceptable growing stock[2] (AGS) vs. the control sites with 60% AGS and the diameter-limit sites which only have 26% AGS. This suggests that the selection system is the best method for improving the quality of your valuable growing stock.

Our study plots also recorded information on dead trees or snags as well as trees that had obvious excavated or natural cavities. We found our control sites to have twice the number of snags as the heavy cut sites and more than 1.5 times as many as the standard cut sites. The provincial guideline for living cavity trees is 6 per ha. The standard cut sites were above this with an average of 7 live cavity trees per ha. However this was significantly fewer by half of what was found on the controls (14 live cavity trees/ha) and the heavy cut sites were also slightly better than the standard cut sites with 8.5 live cavity trees/ha. When both living and dead cavity trees were considered the controls had one-third more cavity trees per ha than either of the other two treatments. As well, the average diameter (dbh) was significantly higher on the controls (38.9 cm dbh vs. 32.9 cm standard and 29.0 cm heavy).

In conclusion, these upland forest ecosystems experience a number of profound changes following harvesting. Many of the changes are significant and involve differences of 20 to 30% or more. Table 1 provides a summary of these forest changes and can be viewed as a general description of the alteration of breeding habitat that may affect forest birds in these woodlots.

Table 1. Summary of average forest changes observed on the harvested study sites as compared to the controls.		
Characteristics	Standard Cut	Heavy Cut
Crown Closure	- 10 %	- 30%
Total BA	- 16%	-35%
Large Diameter Trees *	- 40 % (53%)	- 90% (95%)
Medium Diameter Trees *	-10 % (16%)	- 32% (44%)
Structure	Uneven-aged	Even-aged
Regeneration Density	0	+ 40%
% shrubs	0	+20%
Canopy Species	Oak -22%	Oak –29%
Regeneration Species	0 minor +red oak+red maple-hard maple-beech	0 minor +red oak-red maple-hard maple
Floristic Quality	---	---
Tree Quality (AGS[2] Large Sawlogs)*	(+ 18%)	(- 28%)
Snags	- 40%	- 48%
Cavity Trees	- 33%	- 33%
* Brackets indicate the percentage where all the sites with the single-tree selection prescription are averaged under the standard column and where only prescribe diameter-limit sites are averaged under the heavy column.		

Our comparative work on forest birds began in 1999 with the collection of census data on all of our study sites. We used 200 x 100 m transects, and we visited them three times per year for two years. We recorded all birds heard or seen, and with this information we were able to assess abundance, diversity and presence of the various species observed. Generally speaking forest harvesting does not scare birds away. In fact, the highest levels of diversity and total bird numbers were found on the heavy cut sites. When we compared the bird communities we found those of the heavy cut sites to be significantly different from those found within the controls.

Some species showed a density response to logging. The brown-headed cowbird (BHCO) which is a brood parasite and lays its eggs in other species' nests, had a significantly higher density on the heavy cut sites; brown creepers (BRCR) were significantly more common on the control sites. This "old growth" species nests under thick flaky pieces of bark, typical of big, old trees…and well we know what happened to big, old trees on the heavy cut sites. Other species like the indigo bunting (INBU), a species that prefers openings and small gaps was not present on the control sites. These species nest in raspberry patches, which we very rarely found in the uncut woodlots.

Although the census findings are interesting and seem to indicate some general trends, they cannot be used for assessing the health or stability of bird populations. In order to better understand whether forest bird populations can be sustained in these managed forests we were convinced, by our ecologist Dawn Burke, that we needed to study nesting success. As a forester this has been a big revelation for me. I was clearly unaware of just how many active bird nests there are in any given woodlot during the breeding season.

We selected four primary target species to monitor the impacts of partial harvest on avian nest success. These species have different ecological requirements, which may confer greater/or, lesser sensitivity to habitat changes that occur post-logging. This methodology allows us to determine the impacts of logging on nest success across a large extent of the bird community:

American Robin (AMRO) – is a very common and very widespread edge preferring species, with an increasing or stable population. In our region, the species prefers edge habitat and early successional forests. Robins have a variable nesting habitat, though they often place nests in sapling or small diameter trees, they will also nest in the high canopy of large mature trees. AMRO are considered very prolific with up to three broods (nests per pair) in a season and are of no conservation concern.

Northern Cardinal (NOCA) – like the AMRO this species also prefers edges and will nest low in dense trees and shrubs following logging or other disturbance. NOCA are usually double-brooded and are also not of conservation concern.

Rose-breasted Grosbeak (RBGR) – is a species that uses second growth, edge, and otherwise disturbed habitats and is believed to be much less vulnerable to disturbance than many other species of neotropical migrants. Usually only having one nest per season, it nests predominantly in small saplings, but like the AMRO will nest in the canopy of mature trees. Though not of conservation concern to most ornithologists, RBGR biology is not well known and the population has shown signs of recent decline.

Wood Thrush (WOTH) – has become one of the primary symbols for declining neotropical migratory birds. They breed in the interior and edges of deciduous woodlots, primarily in dense saplings and are usually double-brooded. WOTH populations have declined across many regions and they are of major conservation concern.

Our bird census work (in 1999) gave us a clear indication that these four species were nesting within our study sites. Staff were trained to search for and monitor nests of the target species, cavity nesters and some other species, including a few that are at risk. Located nests were visited every two to six days between early May and mid-July. Nests were monitored to determine the frequency, intensity, and overall impact of parasitism by brown-headed cowbirds. Secondly we observed the nest predation rates. Our most common predators have been blue jays, eastern chipmunks, and raccoons.

Nests were considered successful if they fledged at least one host young, or if the young survived in the nest up to two days before the estimated fledging date (i.e., approx. 10 to 11 days old for WOTH). We found a total of 642 nests of the target species over the four breeding seasons. Outcomes were known for 573 of these and 68% or 389 failed. Most of the failures were due to predation (95%). Few nests failed because only BHCO young fledged (1.5%). Abandonment was low (3%) for nests with eggs present, and failure due to stochastic events (the weather) occurred only once (0.3%).

Rates of nest predation were variable between years and between species. Rates were highest in 2002 and lowest in 2000. Rates varied between 58.5% for WOTH and 69% for NOCA. In all but 2000, we found significantly higher rates of predation in heavy cut sites than the standard cut sites. For the past three years standard cut sites have consistently had the lowest predation rates.

Rates of nest parasitism also varied between species, and between years, with an average rate of 22.72%. Parasitism reached a high of 38.1 % this season, and a low of 11.8% in 2000. Wood thrush were the most heavily parasitized target species. Rates of nest parasitism varied significantly between treatments, with heavy cut sites have significantly higher rates of parasitism and standard cut sites consistently having the lowest rates. These high levels of parasitism support the significantly higher BHCO densities found on heavy cut sites during the bird census. In fact, BHCO was the best indicator of heavy cut sites.

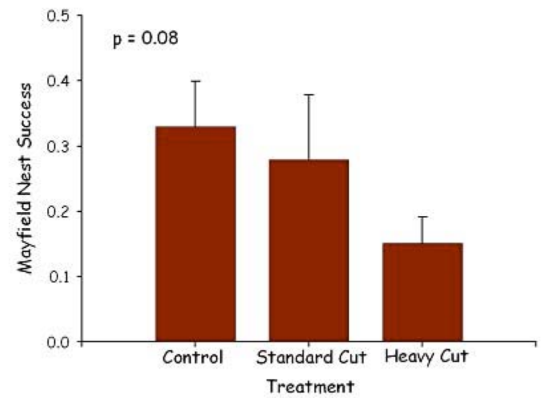

Figure 4: Comparison of Mayfield nest success of rose-breasted grosbeak nests. Data are combined for four years, 2000-2003, and represent average nest success ±

Of our four target species, only the RBGR and WOTH had nest success improved by any of the treatments. RBGR showed sensitivity to logging, with nest success significantly lower on heavily cut sites compared to control sites. This is interesting since RBGR is cited as being "relatively tolerant to habitat disturbance." However, the life history of this species is not well studied, and Breeding Bird Survey trends show a significant decline in this species over recent years. As an indicator of control sites the RBGR is another example of why it is important to maintain tracts of undisturbed forest within our remnant woodland landscape. We now have a masters student pursuing further work on the breeding biology of this species in relation to harvesting disturbances.

WOTH also show sensitivity to logging, with nest success in standard cut sites being significantly higher than that in heavily logged sites. For this species, it seems likely that higher predation rates combined with higher parasitism loads in heavily logged sites are creating habitat sinks, where the population cannot maintain itself. WOTH are an indicator of selection system harvests and seem to be well adapted to successfully breed in the dense sapling layers created. Another masters student will focus on WOTH this breeding season.

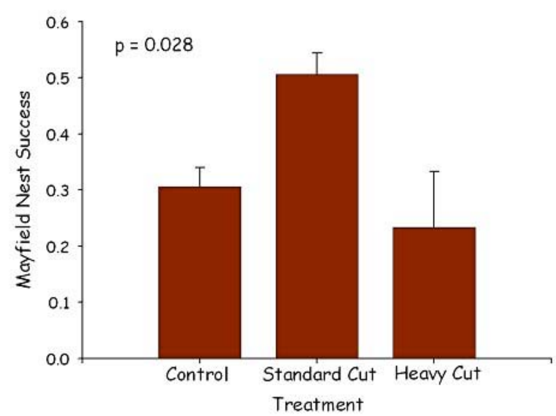

Figure 5: Comparison of Mayfield nest success of wood thrush nests. Data are combined for four years, 2000-2003, and represent average nest success ± S.E (Johnson 1979).

Over the 4 breeding seasons we have found 194 active cavity nests. Our most prevalent primary cavity nesting species were hairy woodpeckers (HAWO n=45), northern flickers (NOFL n=31)), downy woodpeckers (DOWO n=27), and red-bellied woodpeckers (RBWO n=26). We had 3 main secondary cavity nesters: black-capped chickadee (BCCH n=13), European starling (EUST n=11) and white-breasted nuthatch (WBNU n=9). As with the cavity tree survey there were significantly more active cavity nests on the control sites (100) as compared to the two harvest treatments (Standard 57 and Heavy 37). A third masters student will pursue additional studies on cavity nesters.

Conclusions

The impacts of partial harvesting vary between species. As with plants, heavy cut sites have more bird species and more birds due to increases in edge species. Partial harvests can have a significant impact on nesting success of some forest bird species when sufficiently intense. The edge effect associated with BHCO parasitism appears to be showing up on the heavy cut sites. These heavy cut sites have both a greater frequency and intensity of parasitism. Impacts of nest predation vary, though there is a tendency for heavy cut sites to suffer higher rates of nest failure. In both cases the standard cut sites have the lowest parasitism and predation rates.

Diameter-limit Cutting – Diameter-limit cutting changes woodlots the most. These harvests eliminate the large trees and the habitats associated with them. Cutting in this aggressive way increases invasive and edge species and puts pressure on more sensitive species.

Uncut Forests and Parks (Controls) – Uncut forests such as parks used as controls in our study tended to have more cavity nesters, larger trees and more snags. RBGR have significantly higher nest success on these sites. Other species do better in partially harvested forests.

Single-tree Selection System Harvests – With the uneven-aged stand structure, higher quality in large trees and better ratios of trees to shrubs in the understory, we expect these sites will have a more consistent and valuable timber supply. As compared to the diameter-limit prescription the selection system harvests cause less change to the forest and leave conditions which are much more similar to controls. WOTH have by far their greatest levels of nest success on the sites harvested under the selection system.

Final Conclusions

Forest management clearly changes the structure of woodlots and alters a number of habitat components. Woodlots managed carefully under the single-tree selection system seem to provide suitable habitat for most birds in the short term. Our studies have raised a few concerns regarding harvesting effect on overall woodland biodiversity. We are now well into an experimental Phase II of the study which will delve into some of these other questions.

Footnotes

[1] Basal area – the area, in square metres per hectare, of the cross-section of all trees measured at 1.3 metres above ground level.
[2] AGS – acceptable growing stock are trees suitable for retention in the stand for at least on cutting cycle (15 – 20 years). They are trees of commercial species and of such form and quality as to be salable for sawlog products at some future date.

This article appeared in the Spring/Summer 2004 (Volume 35) edition of the S&W Report the newsletter of the Ontario Woodlot Association.