
Microhabitat Characteristics of the Red-shouldered Hawk in Managed Hardwood Forests of Northern Lower Michigan



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Cover Photographs: Red-shouldered Hawk nest in an American beech tree. Inset photos: Vegetation sampling at nest sites. All photographs by David L. Cuthrell.

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ABSTRACT

Microhabitat data were collected in three different zones around 37 Red-shouldered Hawk (RSH) nests in northern hardwood stands in northern Lower Michigan. Utilizing seven years of nest activity and productivity data, we examined the impact of timber management on RSH survival and reproductive viability and relationships of nesting success with stand level and nest tree attributes. Management at nest sites was highly variable, and strong conclusions regarding impact of silvicultural management were impractical. Nest zones had higher canopy basal area, canopy closure, and basal area of beech. Beech was the most common nest tree species, and also constituted the majority of large diameter trees within the study area. Stand thinning did not appear to directly affect hawk productivity, but may have indirectly affected RSH productivity by increasing the proportion of beech trees in RSH habitat, a nest tree species associated with higher nest failure rate than the dominant sugar maple. Large diameter trees other than beech need to be promoted in northern hardwood stands managed for Red-shouldered Hawks.

INTRODUCTION

The Red-shouldered Hawk (*Buteo lineatus lineatus*) is currently listed as a state threatened species in Michigan. It was once common in the southern Lower Peninsula, but as forest and wetland habitat was lost, Red-shouldered Hawk (RSH) breeding range shifted into forested areas of northern Lower Michigan (Brewer et al. 1991). Over its entire range, RSH populations have declined since the turn of the century, which has been widely attributed to habitat loss (Brown 1971, Bednarz et al. 1990, Brewer et al. 1991, Martin 2004).

Red-shouldered Hawk nests are most often associated with mature hardwood forests with large trees (Titus and Mosher 1981, Morris and Lemon 1983, Woodrey 1986, Dijak et al. 1990, Moorman and Chapman 1996, McLeod et al. 2000). Although RSH nests are found in many Michigan forested community types, such as aspen stands, lowland poplar stands, cedar swamps, lowland conifers, and pine-hardwood ecosystems, the primary nesting habitat is that of upland northern hardwoods (Cooper et al. 1999). Many of these nests are in stands that have been subject to a long history of silvicultural management, and research has suggested a detrimental impact to the RSH viability from stand thinning and selective logging (Bednarz and Dinsmore 1982, Morris and Lemon 1983, Bryant 1986, Moorman and Chapman 1996, McLeod et al. 2000, Naylor et al. 2004). However, little is known about the actual impacts of timber harvest on the population viability of RSH in Michigan forests.

The Michigan Department of Natural Resources has proposed draft management guidelines for RSH nesting habitat (Appendix 1), and in some areas actions have taken place. Temporal restrictions and no-cut buffers have been established around existing hawk nests, but the application and effectiveness of

these (still draft) proposals have not been examined. Our foremost objective in this study was to further describe characteristics of RSH breeding habitat in northern hardwood stands at the nest and stand scale. In addition, by selecting nests and stands that have varying timber harvest histories, we hoped to determine the impacts of management on RSH survival and reproductive viability, while assessing the implementation of regulatory activity. Utilizing seven years of nest activity and productivity data (Cuthrell 2006), we examined the relations with stand and nest tree attributes. Insights gleaned from this analysis will be employed to enhance the current Draft Management Guidelines for Woodland Raptors.

METHODS

Study Sites

A total of 37 nest sites were sampled exclusively within well-stocked, pole and saw timber northern hardwood stands (M6 or M9) on state forest land in northern Lower Michigan. The nests were located in one of three forest management units: Pigeon River (10 sites), Gaylord (19 sites), and Traverse City (8 sites) (Fig. 1). The majority of sampling took place on glacial moraine ridges with other sites located on glacial lake plain, ice contact ridge, outwash plain, and flat morainal till plain.

Field Methods

Field work was conducted from August 14, to September 14, 2006. Sampling was timed to minimize disturbance to the hawks, as our sampling coincided with a period when the hawks were not in close proximity to their nests. In fact, although RSH were consistently heard in the vicinity of our sampling sites,

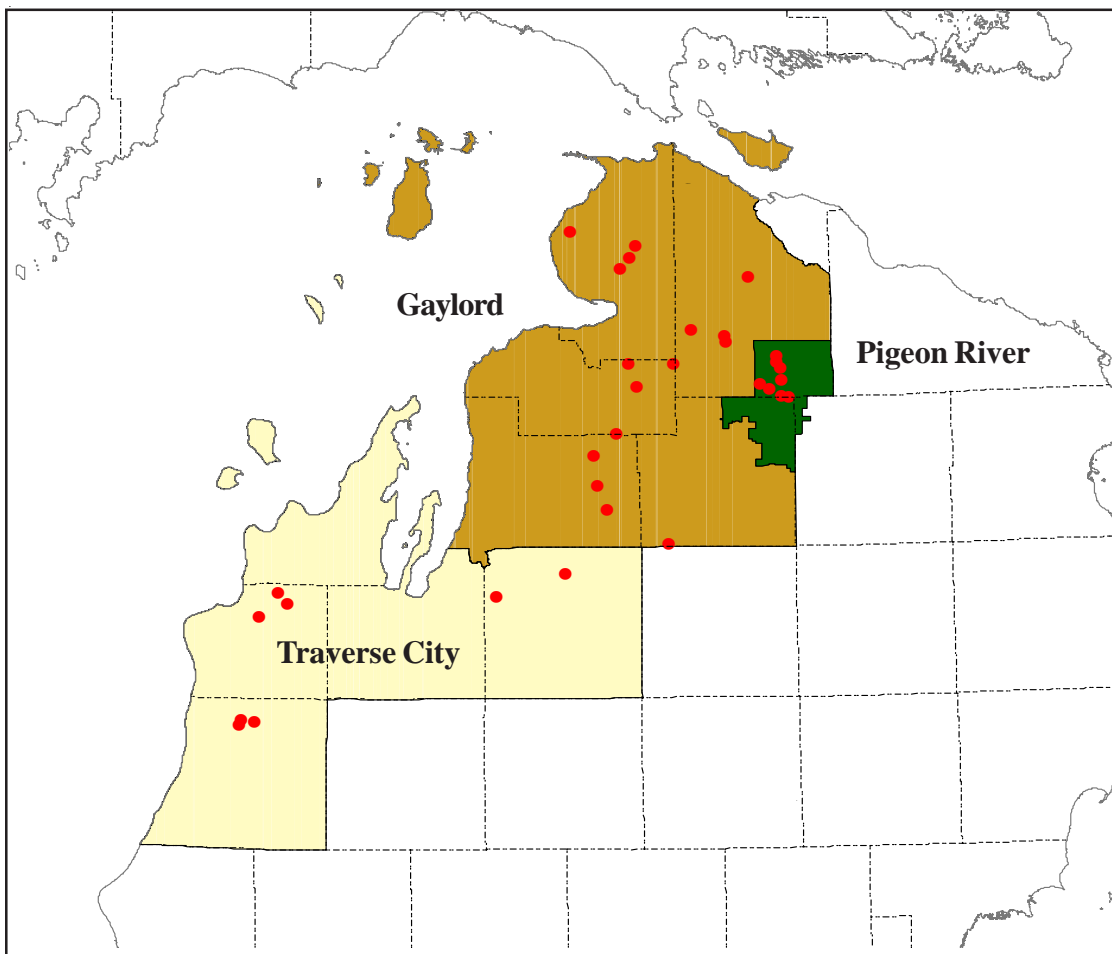


Figure 1. Location of RSH nest sampling sites in the Gaylord, Pigeon River Country, and Traverse City Forest Management Units, northern Lower Peninsula, Michigan.

only one individual was actually seen within close proximity to the nest tree.

Sampling design and plot locations were based on the draft management guidelines for RSH on state-owned lands (for complete guidelines, see Appendix I). These draft management guidelines propose three potential management zones; a nest zone, a buffer zone, and a tertiary zone. The nest zone is a five chain (330 ft) radius buffer around the nest tree, where no cutting or road construction is to take place. Also no other planned activity is allowed between March 1 and August 31. The buffer zone is an area with a five chain radius from the end of the nest zone, where an 85% canopy cover is to be maintained with the aforementioned temporal restrictions to planned activities. The tertiary zone is an area of 25 chain radius outside the buffer zone, where total openings are not to exceed 10% of total area and 80% canopy cover is to be maintained, with similar temporal restrictions to planned actions.

Each sampled nest site contained three sampling plots, one in each management zone. The nest plot

was centered on the actual nest tree. The buffer zone sampling plot was placed at a random azimuth and random distance from the nest plot, keeping stand type and stocking levels consistent with the nest zone. The third sampling plot was placed in the tertiary zone and was located in the same manner as the buffer zone plot. Once a plot site was randomly selected, the sampling plot was subsequently centered on the closest tree deemed suitable for a RSH nest (McLeod et al. 2000). Plots were circular and 1/10 of an acre (11.3 m radius) (James and Shugart 1970).

Sampling included the collection of stand level, plot level, and tree level data (for an example data field form see Appendix II). Stand level data included management history, stocking level, and general topography. For plot level data, measurements focused on forest structure. Upper and lower canopy heights for five canopy dominants were measured, and the age of one dominant tree reaching the overstory was measured by increment borer. Tree density and composition was measured in three separate categories including canopy, subcanopy, and shrub

layer. The species and diameter at breast height (DBH) were recorded for trees in the canopy (trees that reach the canopy or supercanopy that were ≥ 9 cm DBH) and subcanopy (trees not reaching the canopy and were < 9 cm DBH or ≥ 5 m in height). Relative density and relative dominance were calculated for both canopy and subcanopy size classes. Relative density of each species was calculated by the number of stems for that species over the total number of stems for all species. Relative dominance was calculated by the total basal area of the species over the total basal area of all species.

Other plot level measurements included estimates of shrub density, canopy closure, ground cover, and coarse woody debris (CWD). Shrub density was estimated by the number of woody stems in the shrub layer (≥ 1 m and < 5 m) within a randomly selected quarter of the plot. Canopy closure and ground cover were estimated along the cardinal directions from the hypothetical or actual nest tree. Ocular tube readings of canopy conditions were taken at paced intervals five times in each cardinal direction, and 1 m² quadrat ground cover estimates were taken at every other canopy cover reading. Total ground cover (vegetation ≤ 1 m) estimates were based on six cover classes: 0-5%, 6-25%, 26-50%, 51-75%, 76-95%, and 96-100% (Daubenmire 1959). The ratio of hits to misses in the ocular tube gave the percentage canopy cover for that plot. The amount of CWD was assessed on a scale of 1-5 with a ranking of 1 having CWD as absent or limited to small diameter (< 20 cm, 8 in) and of early-successional species composition. A moderate level (3) had trees ranging from 20-50 cm (8-20 in) DBH, species including shade-intolerant, mid-tolerant, and tolerant and/or a range in stages of decay. Plots with high levels of CWD (ranking of 5) had many trees > 50 cm DBH with largely late-successional species composition and a full range in stages of decay. Coarse woody debris rankings of two and four were intermediate between the major three classes.

Tree level data included information exclusively on the nest tree. Data recorded included species, DBH, tree height, nest height, number of support branches, number of branches below nest, and condition of nest tree (live, dead, or decayed).

The productivity and nesting success of RSH was monitored from 1998 - 2006 (Cuthrell 2006). Productivity and nest success was calculated for the 37 nests of this study, and all nests within northern hardwood type stands (M) in northern Lower Michigan. The number of young per active nest was calculated and then broken into two classes: 1) high productivity nests (greater than 1.00 young per active nest), and 2) low productivity nests (having 1.00 or less young per active nest). Nest failure rate was

calculated by number of failed nests divided by the number of active nest years per nest tree. Nests with a failure rate of 50% or higher was grouped into the high category, and those below 50% were grouped into the low category.

Statistical Analysis

SPSS (2005) was used to calculate all statistics. Significance was considered at $P = 0.05$ for all statistical tests. Means of canopy cover, shrub density, total basal area, canopy basal area, subcanopy basal area, and DBH for zone comparisons were analyzed by ANOVA/Tukey HSD pair-wise tests. Means by productivity classes were analyzed by independent variable t-tests. Tree level variables between nest tree and selected random trees were compared using paired t-tests. Relationships between productivity classes and categorical variables including ground cover class, coarse woody debris class, and canopy closure class were analyzed by Chi-square tests including Fisher's Exact Test when needed. Important factors and relationships were determined by analyzing the standardized residuals within the contingency tables (Zar 1999).

RESULTS

Management

Of the 37 nest sites, fourteen (38%) were cut within the last ten years and had no discernible buffer. Fourteen (38%) of the nest sites had not been cut in the last ten years, while eight sites (22%) had been cut in the last ten years and had some form of distinguishable buffer in place. One site had not been cut in the last ten years, but still showed an intact buffer; that site actually had the highest productivity of all nests. Of the nine nest sites with buffers, four had high productivity and five had low productivity. The no-cut buffers ranged from one chain (66 ft) to five chains (330 ft). Among the total sampling plots ($N=96$), 53% had been managed within the last ten years, and a substantial proportion within this group had evidence of management within the last five years. Nest productivity and nest failure had no significant relationship with management.

Nest Trees

Of the 37 nest trees sampled, 24 (65%) were American beech (*Fagus grandifolia*) (Fig. 2). The next most common nest trees were red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), and American basswood (*Tilia americana*) with three each, then sugar maple (*Acer saccharum*) and white ash (*Fraxinus americana*) with two, followed by bigtooth aspen (*Populus grandidentata*), represented

once. The mean DBH for beech nest trees was 63.8 ± 2 cm (25.12 in), while the non-beech nest tree mean DBH was 49.1 ± 2 cm (19.33 in) ($df = 34$, $t = -4.104$, $P < 0.001$). Mean nest tree height for both beech and non-beech was 92.6 ± 2 ft. Beech nest trees had a mean nest height of 38.8 ± 2 ft and non-beech nest trees had a mean nest height of 51.0 ± 3 ft ($df = 35$, $t = 4.033$, $p < 0.001$). Beech trees also showed the largest difference between nest and upper canopy height. The average differences were 53.6 ft and 40.2 ft for beech and non-beech, respectively ($df = 35$, $t = -4.446$, $p < 0.001$).

Paired T-tests indicated a significant difference between actual nest tree DBH and random tree DBH (our selected “nest tree”) ($P=0.004$ and 0.007 for buffer and tertiary zones, respectively). The mean nest tree DBH was 59.2 ± 2 cm (23.31 in), compared to 50.7 ± 2 (19.96 in) and 50.4 ± 2 cm (19.8 in) for the buffer and tertiary zones, respectively. Mean nest tree height was not significantly different from either of the selected hypothetical nest trees.

Species Composition

The overall species composition did not vary much among the nest, buffer, and tertiary zones. The nest zone contained the highest basal area of aspen and sugar maple as well as the lowest basal area of beech and basswood. Overall, 91% of canopy basal area was dominated by five species: sugar maple, beech, red maple, basswood, and white ash (Fig. 2). Sugar maple had the highest relative density and relative dominance in the canopy with 46% and 36%, respectively. Both red and sugar maple combined had a relative density and relative dominance of 57% and 47%, respectively. Basswood had the next highest relative density with 20% followed by beech with 11%. Beech had the next highest relative dominance after sugar maple, with 23%. The subcanopy was dominated by sugar maple with relative density of 67% and relative dominance of 62%. Beech in the subcanopy had a relative density of 11% and a relative dominance of 12%. Red maple, hemlock, and basswood had equal values of relative density and dominance in the

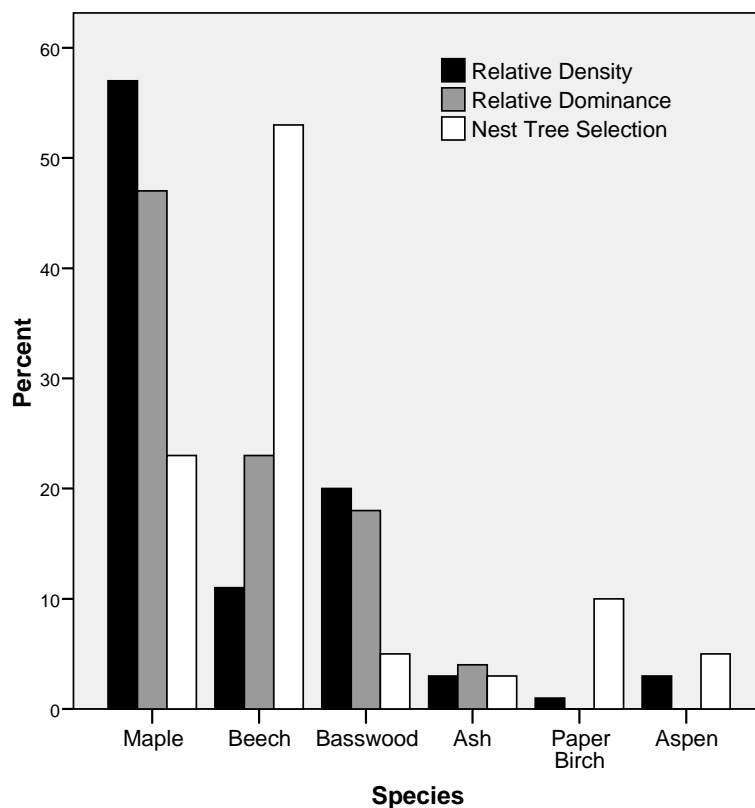


Figure 2. Relative density and relative dominance for sampling area and nest tree selection percentages per canopy species for all RSH nests in northern hardwood stands (M6-M9), northern Lower Michigan.

subcanopy (6%). Beech had significantly higher mean DBH per plot in the nest zone than the other zones ($df=2$, $\chi^2=9.77$, $P=0.008$). Beech was the only dominant canopy species to show this relationship. None of the five dominant canopy species differed in basal area between zones.

Stand Structure by Zone

Stand structure variables that differed significantly between zones were percent canopy closure and mean DBH. The nest zone had the highest mean percent canopy closure with 86%, compared to 80% and 78% for the buffer and tertiary zone, respectively ($df = 2$, $F=5.56$, $P=0.005$). Mean DBH of all canopy trees for each plot differed significantly between the nest and tertiary zone ($df = 2$, $F = 5.726$, $p = 0.005$). The mean DBH per plot for canopy trees was 14.7 in, 13.8 in, and 12.8 in the nest, buffer, and tertiary zone, respectively. Canopy basal area, subcanopy basal

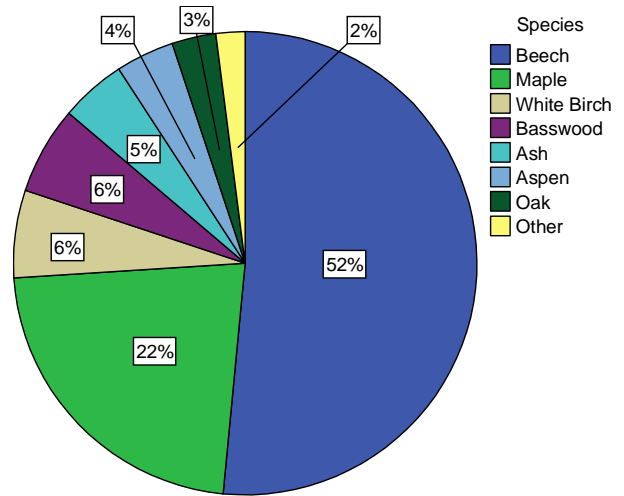


Figure 3. Totals of RSH nest trees by species in all M type stands, northern Lower Michigan.

Variable	Nest Zone		Buffer Zone		Tertiary Zone		P
	\bar{x}	SE	\bar{x}	SE	\bar{x}	SE	
Upper Canopy Height (ft)	86.00	1.19	84.67	1.34	82.44	1.34	0.148
Lower Canopy Height (ft)	52.57	0.93	51.16	1.02	50.70	0.95	0.351
Ground Cover (%)	2.56	0.13	2.73	0.16	2.84	0.14	0.371
Canopy Closure (%)	85.81^{ab}	1.20	80.83^a	2.11	77.59^b	2.14	0.005
Shrub Density (# stems)	32.68	4.62	41.00	10.74	31.17	4.39	0.580
Total Basal Area (ft ² acre ⁻¹)	166.15	4.75	161.57	8.69	158.99	8.82	0.774
Canopy Basal Area (ft ² acre ⁻¹)	143.33	4.89	137.38	8.10	135.69	8.18	0.703
Subcanopy Basal Area (ft ² acre ⁻¹)	23.65	1.92	24.12	2.69	23.22	2.60	0.967
Canopy DBH (in)	14.79^a	0.43	13.86	0.40	12.88^a	0.36	0.005

Table 1. Sample means (\bar{x}) and standard error of mean (SE) for variables measured or derived at all Red-shouldered Hawk nest, buffer zone, and tertiary zone sites. Different letters denotes significantly different means at $P = 0.05$ (Oneway ANOVA, Tukey HSD Post Hoc Test).

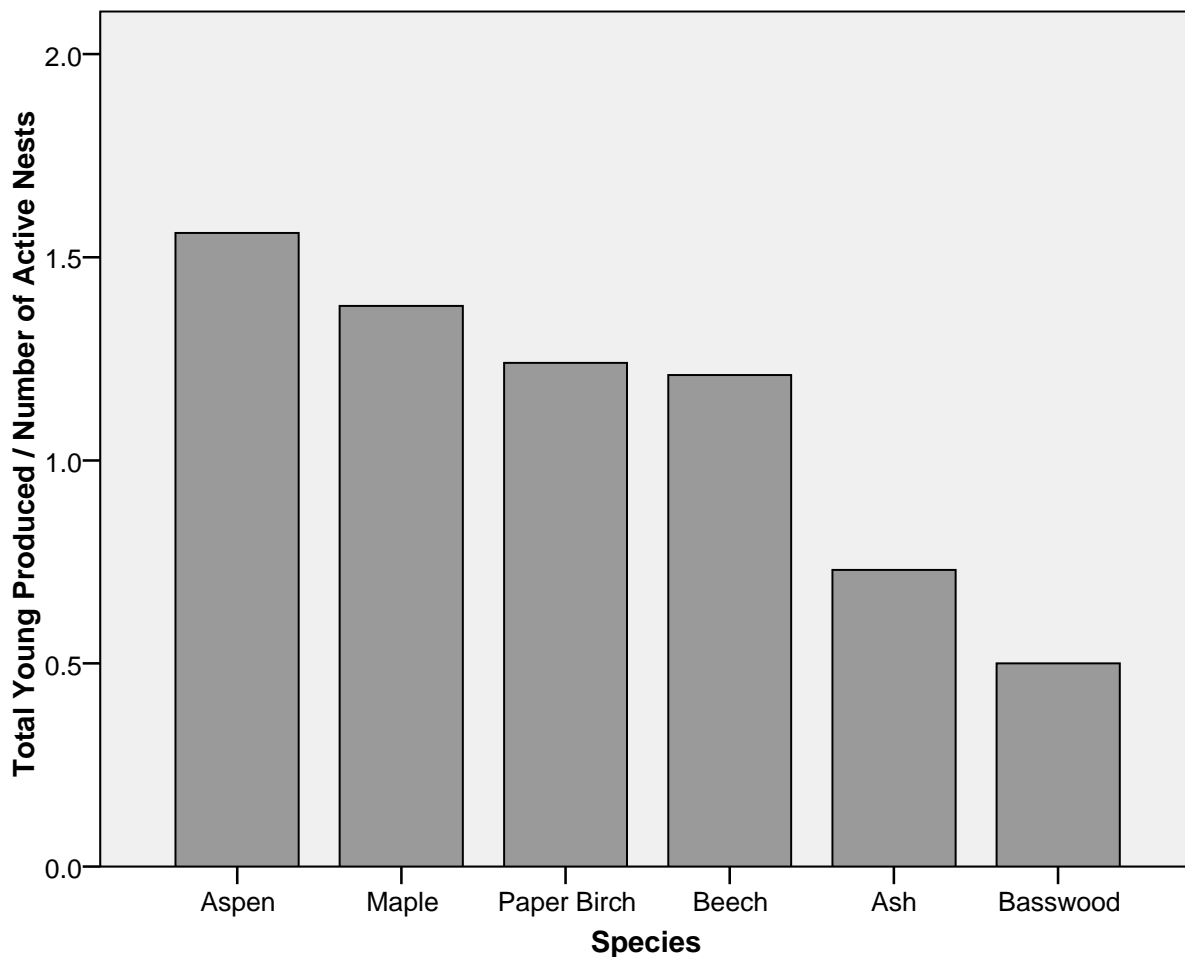


Figure 4. Productivity for all RSH nests for species that have >10 nests on M stands in northern Lower Michigan

areas, upper canopy height, lower canopy height, percent ground cover, coarse woody debris, and shrub density did not differ significantly among the separate zones (Table 1). Over all three zones, beech canopy trees had an average mean DBH per plot of 48.4 ± 1 cm (19.06 in) and sugar maple and basswood were well below with means of 31.5 ± 1 cm (12.4 in) and 33.8 ± 1 cm (13.31 in), respectively. Although not statistically comparable, the mean nest tree DBH of 59.2 cm (23.3 in) and the mean beech nest tree DBH of 64.8 cm (25.5 in) are much greater than mean DBH by zone for all trees and for beech trees by zone.

Nest Productivity and Failure Rate

Within our 37 sampled nest trees, the only forest structure characteristic to have significant relationship with nest productivity was canopy closure. Nests with lower mean canopy closure had higher productivity. Nest failure rate and species had a nearly significant relationship ($p=0.062$) with 79% of beech nest trees (15 of 19) compared to 50% of non-beech nest trees (9 of 18 nest trees) having high failure rates (>50%).

We totaled all active nests on M stands by species (Fig. 3), then compared productivity between species of nest tree by taking the total of all young RSH produced divided by total active nests per species of tree (Fig. 4). When comparing mean young produced per active nest by species, only using those species of nest tree that had ten or more active nests, we found productivity to be related to species ($\chi^2 = 8.464$, $df = 3$, $p = 0.037$). Nests in basswood had low productivity 92% of the time (10 of 11 nests), while 58% of the time beech had low productivity (50 of 86 nests). Nests in maple had high productivity 55% of the time (22 of 40 nests). When comparing failure rate between individual nest trees (again, only those with 10 or more active nests), failure rate also was related to species ($\chi^2 = 7.192$, $df = 3$, $p = 0.066$). Nearly 75% of the time (30 of 40 nests), maple had low failure rates whereas only 52% of the nests in beech had low failure rates. When comparing nest failure rate between the two dominant nest tree species, maple was significantly lower with a mean of 26%, compared to 43% for beech ($t = 2.045$, $df = 124$, $p = 0.043$).

When comparing high productivity nest trees in beech and non-beech trees, a trend was observed regarding the mean difference between canopy and subcanopy basal area, although differences were not statistically significant. In beech nest trees, high productivity nests ($n=11$) had a mean difference of $114.5 \pm 13 \text{ ft}^2 \text{ acre}^{-1}$ compared to low productivity nests' ($n=13$) mean difference of $122.1 \pm 10 \text{ ft}^2 \text{ acre}^{-1}$ ($p = 0.760$). In non-beech trees, high productivity nests ($n=8$) had a mean difference of $123.5 \pm 11 \text{ ft}^2 \text{ acre}^{-1}$ while low productivity nests ($n=5$) had a mean difference of $118.5 \pm 9 \text{ ft}^2 \text{ acre}^{-1}$ ($p = 0.642$).

DISCUSSION

Species composition did not vary much between nest, buffer and tertiary zones. Within nest zones, early successional species such as aspen or paper birch had more of a presence compared to the buffer and tertiary zones. This is most likely due to a close proximity to wetlands or stand type boundary. A prevailing characteristic of nest placement within stands in our study was the close proximity to the stand boundary. This parallels other studies that have found RSH nests in close proximity to wetlands (Titus and Mosher 1981, Bosakowski et al. 1992), and a connection between RSH nests and a diversity of habitats (Gehring 2003). An effective RSH nest site indicator is high basal area (McLeod et al. 2000). With the presence of no-cut buffers, we expected an increased basal area within nest sites to be much more pronounced. In our study, nest zones did have elevated canopy and total basal area; however, differences between the three zones were not significant. The degree to which these stands have been managed could also erode the difference in basal area between zones. Several studies point towards a preference for more mature stands in nest selection (Bednarz and Dinsmore 1981, Titus and Mosher 1981, Bednarz and Dinsmore 1982, Morris and Lemon 1983, Preston et al. 1989). Our results of increased nest zone mean DBH and higher canopy closure support this claim. However, this could also be a result of nest placement in areas with higher site indices. Areas on slopes or near stand boundaries may have different microclimatic conditions and therefore more favorable growing conditions due to proximity to groundwater seepages or wetlands. The no-cut buffers could not explain the increased canopy closure, because when the sites with no-cut buffers were removed, significantly increased canopy closure at nest sites remained.

Red-shouldered Hawk nests tend to show increased success when placed in dominant trees

surrounded by a high density of smaller-diameter trees (Dijak et al. 1990). The surrounding smaller trees likely offer protection from wind and obscure visibility, therefore protecting the nest from predators. In addition, RSH nests are believed to be associated with well-developed understory and ground cover layers (Titus and Mosher 1981). The nest zone in our study had the highest percent canopy closure but also had higher subcanopy basal area. A dense subcanopy layer could influence the canopy closure measurements. Nest sites in our study had the lowest mean ground cover, a direct relationship to the high percent canopy closure, as light filtering through the canopy would stimulate ground vegetation. However, nests with more ground cover had higher productivity. A dense understory could influence predation intensity and prey availability (Preston et al. 1989). Density of subcanopy stems or tall shrub stems in our study did not have a significant relationship with RSH productivity.

Red-shouldered Hawks do not select nests based on species of tree (Bent 1937, Bednarz and Dinsmore 1982, Dijak et al. 1990) as they have been found in many different tree species (14 different species in Northern Michigan). Many suggest that structure is the determining factor (Bednarz and Dinsmore 1982, Morris et al. 1982, Titus and Mosher 1987, Preston et al. 1989). Individual species of trees have unique structural attributes (Horn 1971) and on average, larger-diameter trees increase stability in high wind, and have larger diameter support branches which also increase nest stability (Dijak et al. 1990). In different regions, RSH display alternating patterns of nest tree selection in terms of the tree species abundance and availability on the landscape. In Maryland, Titus and Mosher (1987) found RSH nests to be in predominantly red or white oak (69%), whereas red or white oak comprised 58% of the random trees measured in surrounding habitat. However, in Wisconsin they found 27% of RSH nests in beech trees, where only 0.4% of the random trees sampled were beech. McLeod et al. (2000) found that in one of two study areas in Minnesota, RSH chose quaking aspen as nest trees more often than expected. In Central Ontario, RSH were found nesting in equal numbers of beech and yellow birch, which were believed to be used in accordance with tree abundance (Armstrong and Euler 1983). Likewise, in beech/maple forests of southwestern Quebec, RSH chose almost equal numbers of beech and sugar maple as nest tree (Morris et al. 1982). There, nest trees were found to be 150-200 years old, with mean DBH of 43 cm for beech and 48 cm for sugar maple.

In our study, although beech accounted for 23% of the basal area across all sites, it was the predominant species selected as a nest tree. Nests in beech trees

showed lower productivity and higher failure rates than nests in maple trees. This relationship echoes a study of RSH in southeast Missouri, where Dijak et al. (1990) found RSH nests in pin oaks more often than any other tree, but pin oak nests were also much more likely to fail. In our study area, beech constitutes a high proportion of the large-diameter trees; however, beech trees may not be the most advantageous nest tree for RSH. Dijak et al. (1990) found that successful nests are, on average, located higher than unsuccessful nests. In our study, the average nest height in beech was well below that of non-beech nest trees, but our results could not discern a significant relationship between nest height and failure rate directly. Some authors conclude that a low nest height may protect nestlings from solar radiation, inclement weather, or large avian predators (Bednarz and Dinsmore 1982, Morris et al. 1982, Woodrey 1986). However, nests that are lower in the canopy would also be more susceptible to predation from the ground. Among all RSH nests on M stands, 55% of all instances of documented predation occurred in beech nest trees; these cases involved either the female hawk being killed by what was most likely a great horned owl (*Bubo virginianus*), or nest predation by mammals, possibly raccoon (*Procyon lotor*) or black bear (*Ursus americanus*).

We suspect that with a larger sample size, a significant relationship between nest predation and nest height would emerge. However, this most likely is not the only factor influencing nest predation in beech trees. The large difference between nest height and canopy height for beech trees implies that nests in beech are more visible to predators and scavengers from above and below. The “crotch” of the beech tree on which the nest sits, is wide and easily accessible. The bole beneath the crotch of the tree is usually limb free. Beech nut masts are important resources for black bears in the fall (Lariviere et al. 1994) and when climbing beech trees, bears may encounter RSH nests and re-visit in the spring.

Low canopy basal area combined with increased subcanopy basal area would indicate forests that are still at an early stage of maturity, or recently managed uneven aged hardwoods. Likewise, a stand with increased canopy basal area, and relatively low subcanopy basal area would indicate a relatively mature stand. Although not statistically significant, an interesting trend was noted when analyzing high productivity nests in beech and non-beech trees, and comparing the difference between canopy and subcanopy basal areas. In beech trees, higher productivity nests show smaller mean differences between canopy and subcanopy basal area. For nests in non-beech trees, higher productivity nests show a

greater difference between canopy and subcanopy basal areas. This would indicate that as a stand matures, the importance of beech as a nest tree declines.

Our results do not warrant the conclusion that the act of selective thinning has directly impaired hawk reproduction. We found no strong relationship between managed or unmanaged stands and differential hawk productivity. Contrary to what was expected based on literature review, we observed a few instances of an individual changing nest location from an un-thinned stand to a thinned stand, immediately after management occurred. Rather, timber management may have an indirect effect on RSH by limiting the availability of suitable nest trees. Michigan forests of today have smaller trees and a higher tree density than circa 1800 forests (Leahy and Pregitzer 2003). Nearly 60% of total hardwood sawtimber in Michigan comes from trees 43.2 cm (17 in) DBH or less (Leatherby and Brand 2003). In the relatively even-aged northern hardwood stands where our study occurred, average tree DBH was well below that of the mean nest tree DBH [mean canopy tree DBH for all zones was 35.4 cm (13.9 in), while mean nest tree DBH was 59.2 cm (23.31 in)]. Because nest tree availability has been speculated to be the limiting factor in RSH populations (Titus and Mosher 1981), the scarcity of large diameter trees may be further impacting RSH viability. In addition, as beech bark disease becomes more prevalent (Storer et al. 2005), the availability of beech as nest trees may diminish. Large diameter trees (45-65 cm or 18-25 in) need to be left in order to take the place of beech, both as a more suitable nest trees, and as large beech become less common on the landscape.

MANAGEMENT CONSIDERATIONS

Our goal of assessing current draft RSH management guidelines was difficult to achieve as our sample size was quite small due to inconsistent management practices throughout our entire study area. It is difficult to assess guidelines when they are not being followed consistently. Our study did not find a significant negative impact from thinning; however, more research is needed on a larger sample size of nest trees to better delineate management histories and control for landscape and eco-regional bias. Based on our results, land managers should focus on retaining tree species other than beech in active RSH territories. Because nest trees seem to be the limiting factor, and impact from beech bark disease is increasing throughout the landscape, the practice of girdling large beech trees in order to promote snags should be closely scrutinized. If beech undergoes a decline throughout the region, other species of large diameter

trees will be required to maintain RSH populations in Michigan. We suggest that the retention of a diversity of large diameter trees be emphasized in the draft RSH management guidelines.

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Management Guidelines for Red-shouldered Hawks on State-owned Lands in Michigan

PURPOSE

These guidelines were developed through a cooperative effort in the form of the Woodland Raptor Working Group (WRWG). The WRWG was formed in response to public suggestions to prevent elimination of red-shouldered hawk habitat on state-owned land. With the DNR Wildlife Division acting as the lead, the group of individuals with hawk expertise was gathered, including personnel from DNR Forest Management Division, USDA Forest Service, The Nature Conservancy, Lake Superior State University, and Michigan Natural Features Inventory. The WRWG established these guidelines for the red-shouldered hawk with the intention of implementation on state-owned lands, to serve as an example to private landowners, and as a pilot for future management guidelines for other community types.

INTRODUCTION

The red-shouldered hawk (*Buteo lineatus*) is listed as threatened in the state of Michigan. The species historically had a statewide distribution but since the early 1900s has not been a common resident of the southern Lower Peninsula. Known nesting areas now exist in the northern Lower Peninsula (NLP). Nesting occurs sporadically in the southern Lower Peninsula, where declines are thought to be due to the loss of extensive, mature lowland forests. Confirmation of nesting in the Upper Peninsula was not recorded until 1978 (Postupalsky 1980). Breeding evidence has been found in eight Upper Peninsula counties since then (Brewer et al. 1991). The Atlas of Breeding Birds of Michigan (1991) reports 119 confirmed nesting sites in Michigan.

Some believe that the primary cause for decline of the red-shouldered hawk in Michigan is due to the reduction of its forest habitat. Other factors involved in declines elsewhere include development of buildings and roads (Bednarz and Dinsmore 1982), forest fragmentation (Morris and Lemon 1983), and possibly pesticide contamination (Campbell 1975). In northeastern Iowa, Bednarz and Dinsmore (1982) recommend maintaining woodlands averaging 304 acres of floodplain forest and 173 acres of upland forest within 3200 feet of a nest. They also suggest that each pair may require a territory as large as 615 acres. The same study also suggested that mature forests be maintained at 370 to 1,000 trees for every 2½ acres with openings comprising around 15% of suitable habitat. In general, disturbance within an approximate one-half mile radius of a nest or breeding activity center should be kept to a minimum (Evers 1994).

Red-shouldered hawks have traditionally been associated with bottomland or floodplain forests. In the NLP, upland deciduous forest appears to be an important factor in this species' territories. Surveys in the NLP and habitat analyses in 1998 by the Michigan Natural Features Inventory (MNFI) found that most (93%; n~32 nests) of the active nests were located in upland deciduous forests. In southern lower Michigan, where larger tracts of upland deciduous forest are lacking, the species is nearly always restricted to bottomland forests. These analyses also found that wetlands appear to be an important component in the nesting sites; 57% were located within 1/8 mile of a wetland. Forest patch size was >300 acres for 56% of the nest sites; and patches of at least 200 acres held 20% of the remaining nesting sites.

The majority of nesting birds arrive from wintering areas between late February and early April. They are highly territorial and their aggressive vocalizations during the nesting season make nesting areas relatively easy to locate. Territories are utilized for several consecutive years, with pairs often using several nests within the territory (Craighead and Craighead 1969). Red-shouldered hawks are usually on nesting territories by mid-March, with incubation commencing from approximately April 1 to mid-May. Fledglings will leave the nest by July 1 and remain on or near the nesting territory until migration in September.

In northern Iowa, red-shouldered hawks usually obtain most of their prey from openings created by wet meadows within forested areas (Bednarz and Dinsmore 1985). This species appears to depend on both wetland and upland components of its habitat to meet foraging and nesting needs. Foraging use may even shift from year to year, depending upon prey availability in different habitats. It is unclear, at this time, how and when wetland areas are used by red-shouldered hawks in northern Michigan, but management actions that maintain adequate prey base in both uplands and wetlands are presumably desirable.

OBJECTIVES

The objectives of these guidelines are to specifically guide the forester or biologist in management decisions when a hawk nest is found during timber marking. These Guidelines are interim until additional evaluation of the red-shouldered hawk population and nesting areas is done, at which time the Guidelines will be revised as needed. The Guidelines are to, ultimately, provide management recommendations to the Michigan Department of Natural Resources which (a) maintain or increase the number of successful nesting pairs and (b) define when and where to manage for red-shouldered hawks and associated species on state-owned land.

USE OF GUIDELINES

These management guidelines are intended for upland and lowland hardwood forests in the north portion of the Lower Peninsula. Southern Michigan nesting areas are generally located in bottomland forests and are linear in shape along watercourses, for which these Guidelines would be inappropriate. Currently there are too few nests in the southern population to evaluate nesting situations and for which to develop guidelines.

HABITAT REQUIREMENTS

Red-shouldered hawks require large, relatively mature, well-stocked lowland hardwoods or upland hardwood stands in close proximity to wetlands or other water bodies.

Nesting habitat in northern Michigan

Nesting habitat primarily consists of well-stocked pole or sawtimber stands (stocking densities 6 and 9) with a closed canopy (80 - 100%) and basal area of at least 98 square feet per acre. Canopy closure less than 80% tends to encourage red-tailed hawk (*Buteo jamaicensis*) occupancy. Wetlands are also an important component of red-shouldered hawk nesting habitat. Nesting areas are usually located within 1/8 to 1/4 mile of wetlands or other water bodies. Red-shouldered hawks exhibit a high degree of nest site fidelity, and often return to the same nest tree or alternate among several suitable nest sites within the same nesting area from year to year. Suitable nest trees typically exceed 18 inches in diameter and contain a sturdy crotch near the main trunk in the lower portion of the canopy. Nests have been found in a variety of tree species (typically deciduous, e.g., beech and maple), but ultimately tree structure is the limiting or determining factor. Finally, red-shouldered hawks can be sensitive to disturbances in the immediate nesting area, particularly early in the nesting season when prolonged or frequent disturbances can lead to nest abandonment. Fledglings remain in the nesting territory for 8-10 weeks or more after fledging. During this time the parents are still attentive and feed the young infrequently.

Foraging Habitat

Red-shouldered hawks typically forage in wetland habitats such as lowland hardwoods, lowland conifers, lake and stream edges, and a variety of small, wetland openings and upland openings.

MANAGEMENT GUIDELINES

These guidelines describe concentric circles of decreasing management intensity from the nest tree to the outermost zone. The first zone, or Nest Tree Zone, will be that surrounding the nest tree with each successive zone encompassing a larger area (Figure 1). This is surrounded by the Buffer Zone, which is

surrounded by the Tertiary Zone. The total acreage of all zones around a nest tree should approximate 385 acres, a figure that was derived from roughly averaging territory sizes cited in the literature and acreage that was considered attainable and maintainable by state forest managers.

Each nest area may contain more than one nest tree and overlapping of zones within a nest area will occur. When nests are located when hawks are not on nesting territories, a judgement call on the part of the forester or biologist will need to be made to determine the activity status of the nest. If the nest is disheveled or in obvious disrepair, it cannot be assumed that it will be used in the next breeding season, and may be ignored. However, if the nest looks as though it has been maintained, an assumption can be made that it will be used and the area should be maintained as active red-shouldered hawk nesting habitat.

Nest Tree Zone

Definition:

- five (5) chain radius from nest tree (from 0 to 330 feet from the nest tree)
- ~8 acres

Guidelines:

- no cutting
- no roads constructed
- no planned activity between March 1 and August 31
- attempt to minimize unplanned activity as much as possible

Buffer Zone

Definition:

- five (5) chain radius beyond Nest Tree Zone (from 330 to 660 feet from the nest tree)
- ~24 acres
- no roads constructed

Guidelines:

- apply “Big Tree Management” as defined by DNR Forest Management Division (see Appendix)
- maintain 85% average canopy closure
- no planned activities between March 1 and August 31
- attempt to minimize unplanned activity as much as possible

Tertiary Zone

Definition:

- northern hardwoods or mixed hardwoods and conifers (from 660 to 2310 feet from the nest tree)
- 25 chain radius beyond Buffer Zone
- ~354 acres
- maintain 80% average canopy closure

Guidelines:

- total openings will not exceed 10% (35 acres) of total area
- no planned activity March 1 through August 31

General Guidelines

The wildlife biologist who is responsible for wildlife management in the area of a nest has the final decision-making responsibility on red-shouldered hawk management in accordance with these guidelines.

Zones should focus on the nest tree (i.e. the nest tree should be as close to the center of the defined zones as possible). Shape of zones need not be maintained in a circle as depicted by Figure 1 if forest or landform structure deems it impractical, in which case acreage recommendations will be applied (Figure 2). However, unsuitable habitat, such as open water, grassland, and, but not limited to, early successional habitat types, should not be included in the total acreage of any zone. If appropriate habitat either extends onto or is otherwise present on adjacent private land, it can be considered part of the zone acreage. If the line of the protection zone passes through a habitat type, the extent of that habitat type should be included in that zone until the maximum acreage of that zone is met (Figure 3).

Multiple nests

If more than one useable nest is found in an area and they are ½ mile apart or less, the zones should encompass both nests and the halfway point between the nests should be considered the center of the zones (Figure 4). The distance to the outside edge of the zones is measured from this centerpoint and the acreage within the zones can remain the same as if there were only one nest.

The definition of an opening is an area where the height of a cover type is shorter than the surrounding type. Its impossible, and impractical, to more strictly define an opening for hawk

management purposes, although two to five year-old (or six to eight feet in height) aspen may function as an opening for red-shouldered hawks.

Planned activity includes, but is not limited to, forest management activities under direct control of the forest manager or wildlife biologist.

Future Directions

While a nest-site approach may provide some immediate protection for this species, a landscape-based management approach may be more appropriate and necessary to ensure long-term population viability of the red-shouldered hawk in Michigan. Red-shouldered hawks, and raptors in general, typically have large territories and use different parts of the landscape for different aspects of their life history. For example, adult red-shouldered hawks in northern Michigan typically nest in relatively mature, upland hardwoods and forested floodplains, but forage in nearby wetlands and adjacent forest stands. Fledgling red-shouldered hawks disperse from the nest, and may use components of their parents' nesting territory or habitat outside the territory. Little information is currently available on habitat use and requirements of fledgling red-shouldered hawks. Also, this species may use alternate nest trees within the same territory from year to year. Distance between alternate nest sites can range from 0.25 mile to 0.50 miles for one pair, depending upon the amount and condition of available habitat. Finally, this species may require certain habitat conditions at the landscape scale. For instance, some portion of the landscape around nesting territories may need to be largely forested to help reduce the risk of predation. A fragmented landscape also could lead to increased competition from other hawks and owls.

A landscape approach would help ensure that habitat required for different components of this species' life history and ecology is provided. This approach would account for some of the uncertainties or gaps in our current understanding of the species' ecological requirements as well as requirements of individual nesting pairs. Providing habitat for red-shouldered hawks at the landscape scale would also benefit a number of wildlife species with similar habitat requirements (e.g. forest-interior birds).

A landscape-based management approach basically entails management of suitable habitat for red-shouldered hawks at a larger scale than individual nest-sites. Red-shouldered hawk nests appear to be concentrated on the landscape in some parts of the state. Examples of such concentrations include parts of the Indian River State Forest and the Dog Lake area in the Pigeon

River Country State Forest area. These types of areas, sometimes referred to as core areas, would be managed to maintain or increase suitable habitat for this species, and would serve as primary management areas for the red-shouldered hawk. Ultimately, a core area would be an area in which red-shouldered hawks occur and successfully reproduce. These core areas would potentially function as source populations for the rest of the state. Timber harvesting may be somewhat limited in core areas, and trade-offs in timber harvest intensity may need to occur. Habitat outside core areas could be more intensively harvested or managed for other forest values (e.g. intolerant tree species, grouse management, elk management, etc.). In some cases, management of large tracts of suitable red-shouldered hawk habitat may not be possible due to land ownership patterns. In these instances, management may be limited to the nest-site approach.

Core areas can be delineated by overlaying nest-site data onto forest area inventory data to identify concentrations of nest-sites located within large mosaics of contiguous, relatively mature deciduous forest with adjacent wetland complexes. Geographic Information Systems (GIS) can be utilized to map existing habitat areas and to identify potential management or core areas. Systematic surveys and monitoring of red-shouldered hawk nest-sites have been initiated to determine the species' distribution and reproductive success on state forestland. Systematic surveys of potential habitat within all forest areas in the northern Lower Peninsula and Upper Peninsula have been proposed for the next five years contingent upon available funding and personnel. In 1999, systematic surveys of the Pigeon River Country and Indian River Forest areas will be completed. Completion of systematic surveys should provide the necessary data for identification of core areas in the state. A variety of management options may be applied in core areas. These may include big tree management, old growth designation, and/or standard operating procedures for northern hardwood management. Nests should be monitored to determine impacts of management strategy. Management of core areas should be evaluated and adapted over time, as necessary.

Southern forest nesting areas (south of the tension line), such as the river corridor in the Manistee National Forest, will continue to be monitored and population growth will be encouraged to the extent possible in the smaller forest tracts. Comprehensive surveys of red-shouldered nesting areas are needed in these areas.

These guidelines are intended to be a living document that can be modified as needed to accommodate new information that will benefit the red-shouldered hawk and associated species.

They are currently meant to provide guidance for the management and future expansion of this species in Michigan.

DRAFT

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Appendix

“BIG TREE” SILVICULTURE IN NORTHERN HARDWOODS

These guidelines are written for the objective of providing old growth attributes and greater diversity to managed Northern Hardwood stands while continuing to provide quality wood products for human consumption. It is intended to be used in stands to compliment adjacent “old growth” areas and to provide another silvicultural management choice for Northern Hardwood forest cover type.

- 1) For stands that are best characterized by the 1.3 “Q” curve, maximum BA of approximately 85 ft² (trees five inches DBH and greater) and a maximum DBH of 22 inches, follow regular single-tree selection/gap regeneration guidelines with the following modifications:
 - A. Retain and Restore (R/R) all native species common to the Northern Hardwood type including some of moderate tolerance.
 - B. Work toward a stocking of about 95 ft² BA of which about 25 ft² should be in trees that exceed the standard 22 inches maximum DBH.
 - C. R/R all size classes (no set maximum DBH but no more than 10% of crown cover should be in trees greater than 24 inches DBH).
 - D. R/R at least fifty crop trees/acre in size classes six inches and greater (out of a total of about 130 tree/acre).
 - E. R/R five to eight trees/acre in the 24 inch or greater size classes. About half of these should be in “super crown” trees (full, dominant crowns sticking above most of the stand). This should total about five to ten percent of the stand crown cover.
 - F. R/R dying trees (expected to die within one to ten years) of all size classes with at least an average of two trees per acre total in the ten inch or greater DBH classes (1 to 2% of crown cover). Retain those high-risk trees that provide the least crown competition, have the least value for wood products and have the greatest wildlife and diversity value.
 - G. R/R den trees and nest trees that have proper structure for this purpose. Include trees that have the potential to develop to develop into den and nest trees.

- H. R/R snags and large woody debris. Much of this will be recruited from other categories and remaining trees not specifically relegated to any of these categories. This recruitment will come about from natural death, girdling and other such activities. Residue from logging activities can be designed to provide additional wood debris.
 - I. R/R regeneration gaps. Provide three to five crown gaps per acre every ten to fifteen years. Gaps should vary in diameter from 30 to 60 feet and should equal approximately eight percent of the crown cover area. For areas to be managed for the red-shouldered hawk, make no more than one regeneration hole per acre.
 - J. R/R a number of trees of species that have been removed from the Northern Hardwood type. Examples include white pine, oak, hemlock, cedar and ground hemlock. This may require planting in larger regeneration gaps and protection from deer.
- 2) For stands that are best characterized by the 1.7 “Q” curve, i.e. heavily stocked with trees in the 6, 8, 10 and 12 inch DBH classes:
- A. R/R all native species common to the Northern Hardwood type including some of moderate tolerance.
 - B. Identify 50 crop trees per acre and perform a Crop Tree Release. Trees identified as crop trees should include as many different tree species and as many “super crown” trees as possible.

Additional trees can also be marked as long as the overall percent crown cover does not drop below 80%. While there is no direct correlation between basal area and percent crown cover, residual stocking after marking should be in the 70 ft² to 80-ft² basal area range.
 - C. R/R dying trees. Between one and five live trees per acre should be marked for girdling in order to hasten the development of snags, dying trees and dead and downed timber. Also, retain high-risk trees that provide the least crown cover competition, have the least value for wood products and have the greatest wildlife and diversity value.

- D. R/R both den and nest trees. In addition, the goal should be to perform a “Crop Tree Release” on one potential Raptor nest tree per acre.
 - E. Make between one and five 30 to 50 foot regeneration holes per acre. For areas to be managed for the red-shouldered hawk, make no more than one regeneration hole per acre.
 - F. R/R tree species that have been eliminated from the northern hardwood type, e.g. white pine, hemlock oak, cedar and ground hemlock. This may require planting in larger regeneration gaps and protection from deer.
- 3) For stands that are best characterized by the 1.5 “Q” curve, i.e. acceptable representation in the 10, 12, 14, 16 and 18 inch DBH classes but overly stocked in the 6 and 8 inch DBH class, follow the guidelines for the 1.7 “Q” curve given above.

Real-life situations will undoubtedly require modifications to these recommendations.

Also note that it is possible for any specific tree to serve multiple categories and that not all of the trees in a stand will be “categorized.” Within most northern hardwood stands, there are more than enough trees to fill the needs of these categories and then some.

Figure 1. Simple diagram of management zones

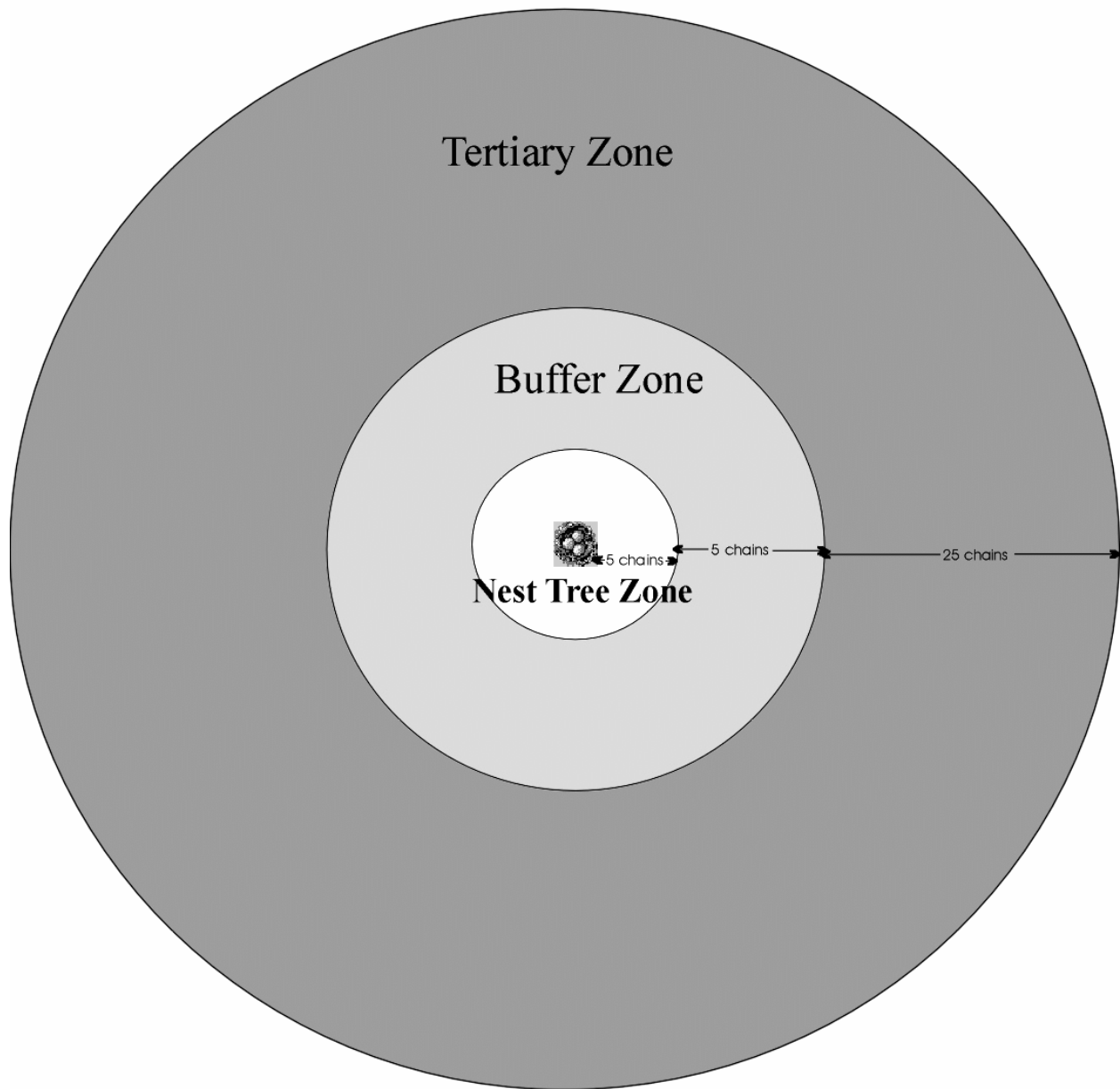


Figure 2. Example of management zone configuration to avoid unsuitable habitat

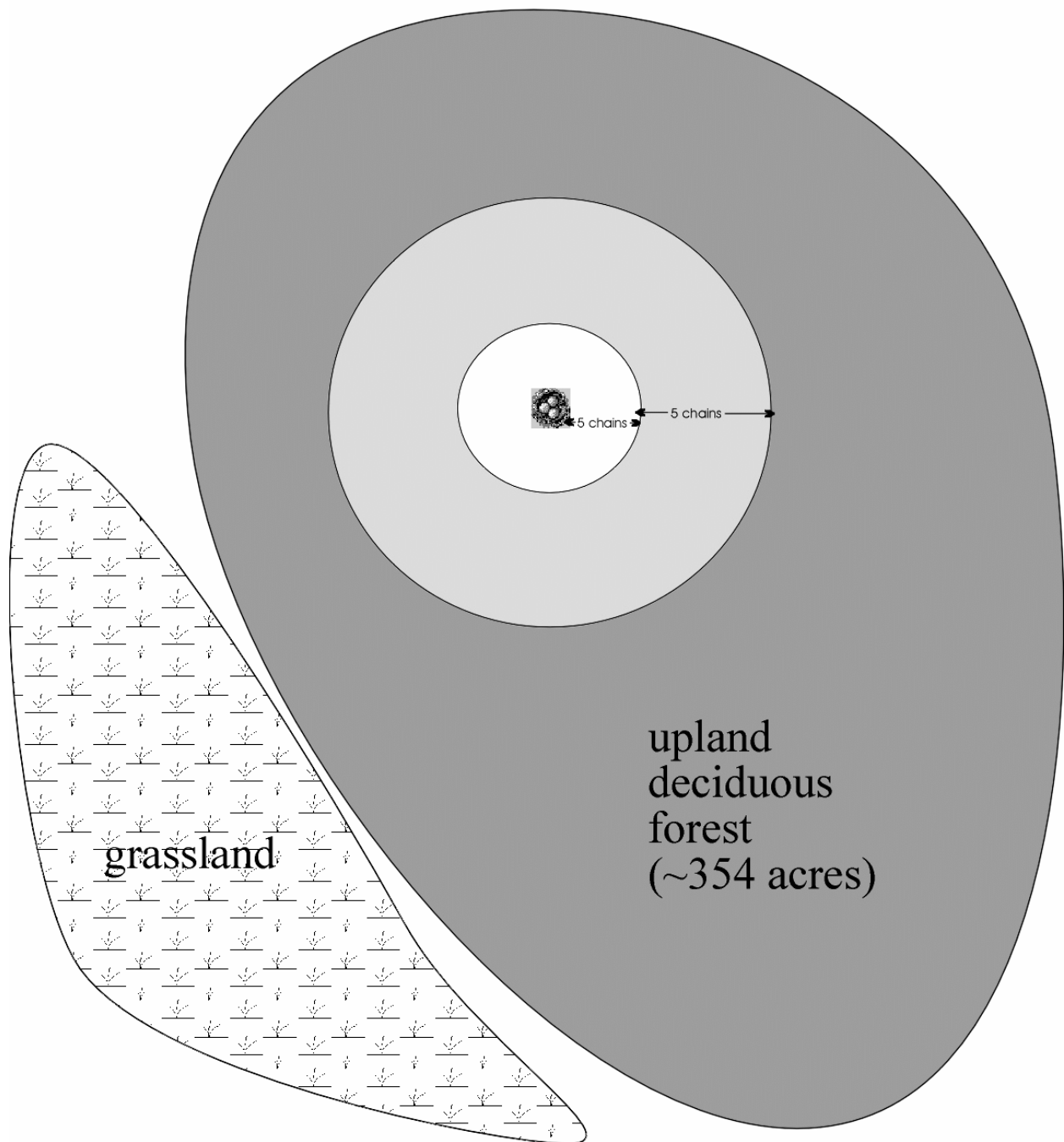


Figure 3. Example of management zone configuration when cutting unit intersects protection zone. The part of the cutting unit that overlaps protection zone (dark hatches) assumes that level of protection.

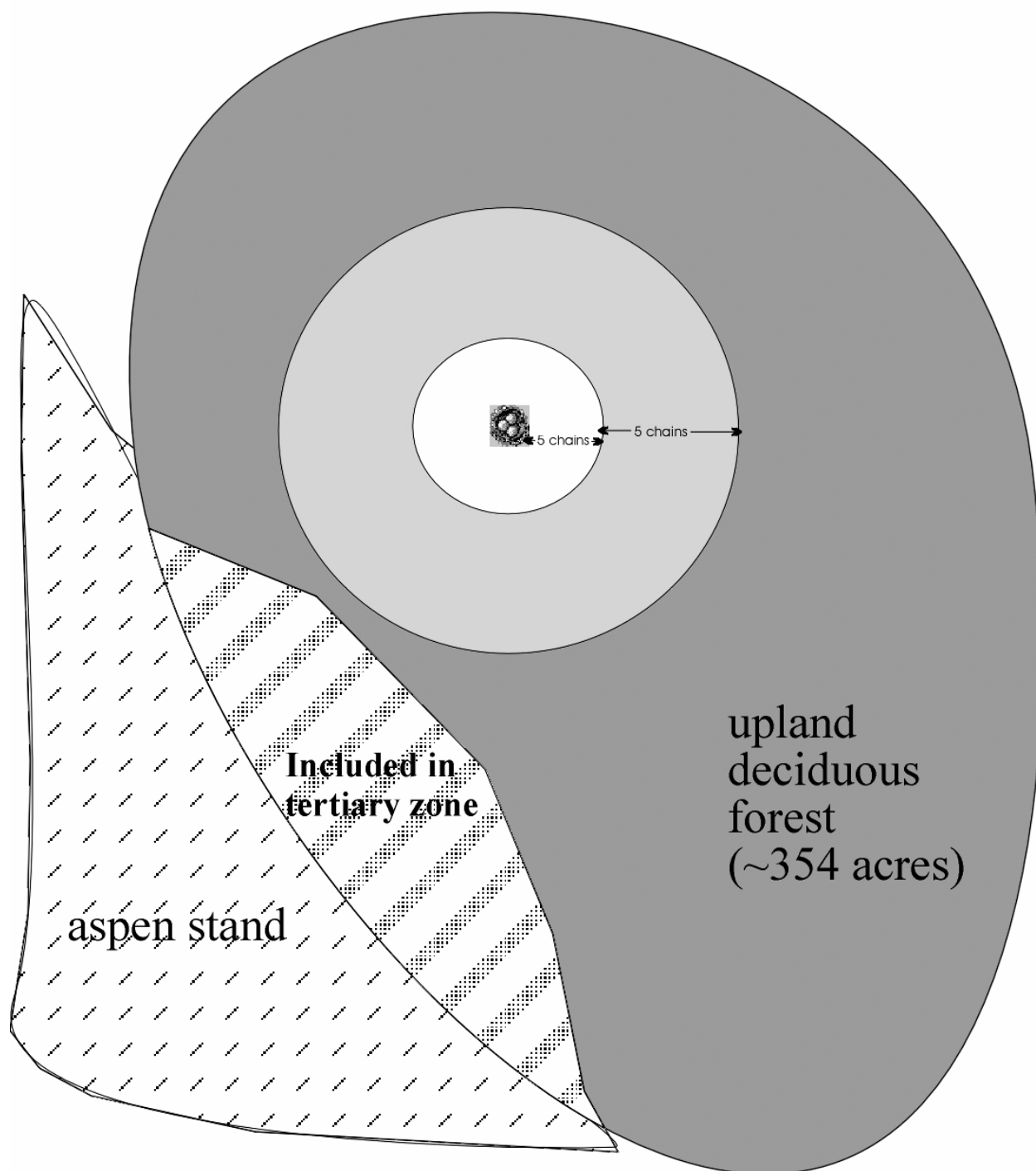
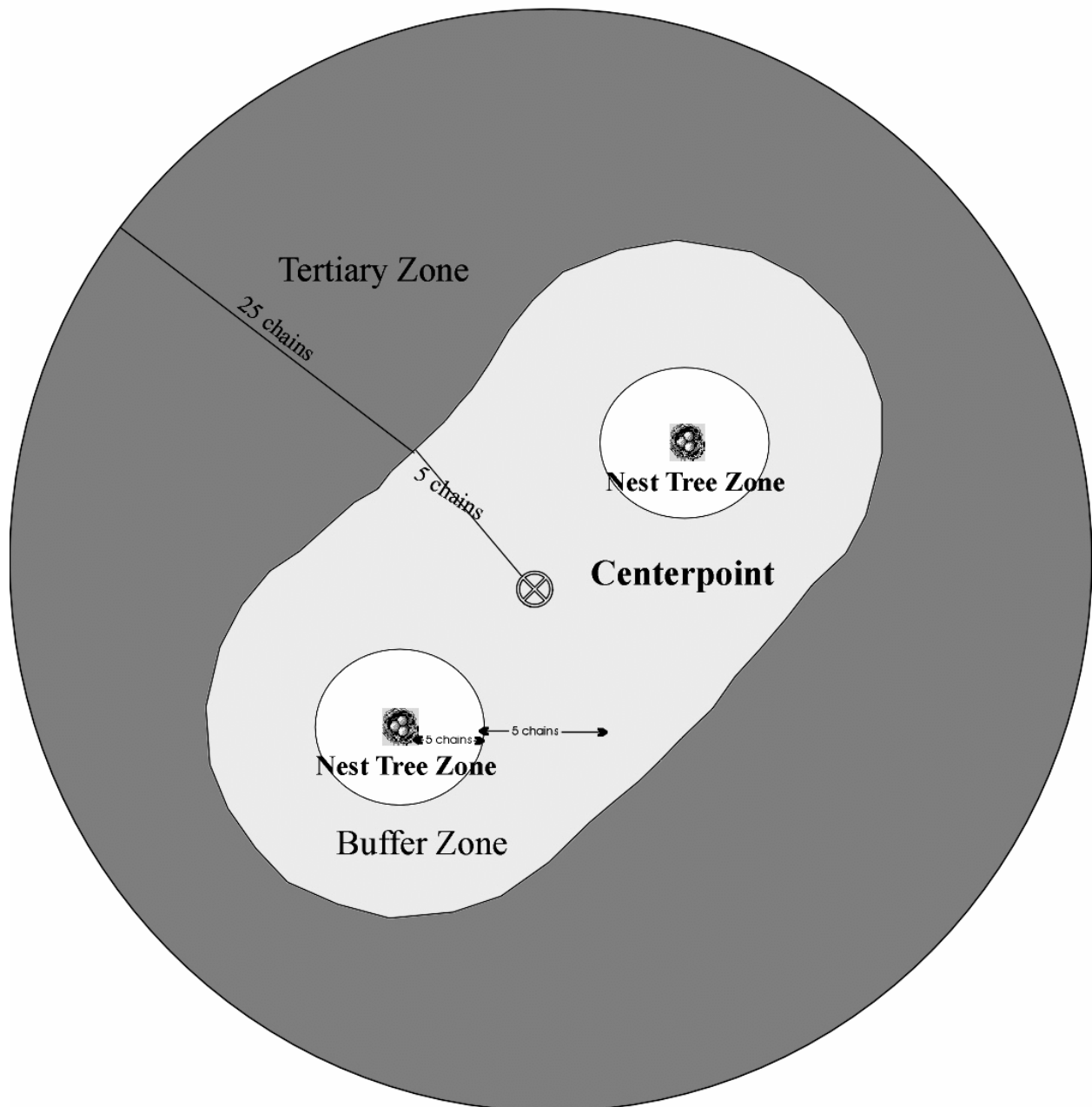


Figure 4. Simple diagram of management zones including multiple nests.



RED-SHOULDERED HAWK MONITORING FORM

Forest Area: _____ Compartment and Stand #: _____ Nest #: _____

Zone (circle one): Nest Buffer Tertiary Date: 08/ /2006 Surveyors: Dave Cuthrell and Chris Weber GPS: _____

Topography: _____ Management: _____

Nest tree species: _____ Nest tree DBH (cm): _____ Nest tree ht. and nest ht. (feet): _____

nest support branches: _____ Nest orientation: _____ # major branches below nest: _____

Nest tree condition (circle one): live dead decayed Elevation at nest or plot center: _____

Dist. to nearest trail/rd., upland opening, and wetland (specify type) from plot center: _____

Canopy height (ft) and age of 1 canopy dominant: _____

1)	2)	3)	4)	5)	Mean =
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Tenth acre circle plots (11.3 m radius) (for subcanopy plot randomly select quadrat to sample) Basal Area (10X prism): _____

Species	Tree density ≥ 9 cm dbh	Subcanopy density < 9 cm and or ≥ 5 m ht
Sugar maple		
Beech		
Red oak		
Basswood		
White ash		
Trembling aspen		
Bigtooth aspen		
White birch		
Yellow birch		
Hemlock		
White pine		
Black cherry		
Ironwood		
Snag (identify species)		

Shrub plot (5 m radius) (shrub layer ≥ 1 m and < 5 m) number of woody stems: _____Ground cover plot (1m²) estimated percent cover (gc) and depth of duff layer (dd) measured in cm:

1)	2)	3)	4)	5)	6)
7)	8)	9)	10)	Mean gc =	Mean dd =

Notes on species composition of shrubs, saplings, and ground cover: _____

Canopy closure measured using ocular tube readings paced along transects of cardinal bearings:

East/West				North/South			
#	+/-	#	+/-	#	+/-	#	+/-
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Qualitative assessment of coarse woody debris (see reverse for definition of classes): Class 1 2 3

Notes on management of plot and surrounding area: _____

Notes on species composition and structure adjacent to plot but not captured by plot: _____

DEFINITIONS AND SAMPLING GUIDELINES

PLOT SELECTION: Use nest tree within Nest Zone or randomly selected point within Buffer Zone or Tertiary Zone as plot center. Determine randomly selected points in Buffer Zone and Tertiary Zone by spinning compass to determine bearing and use random number table to determine distance to pace. If selected point does not meet sampling criteria, spin the compass again and select new number for distance.

CANOPY, SUBCANOPY, AND SHRUB PLOTS: The nest tree or the plot center will serve as the center for the Canopy and Subcanopy plots. The **canopy plot** is a tenth acre circular plot with a radius of 11.3 meters. Canopy trees are ≥ 9 cm dbh. Within this plot the diameter at breast height of all canopy trees will be measured and these trees will be identified to species. The canopy height of one tree from each quadrat (NE, SE, SW, and NW) will be measured. The height of a 5th tree will be measured within the quadrat that is randomly selected for the subcanopy subplot (see below). In addition the age of one or more canopy trees will be determined.

The **Subcanopy Plot** will be selected by randomly selecting one quadrat from the tenth acre circular plot by using a random number table or a compass spin (NE=1, SE=2, SW=3, and NW=4). Subcanopy trees are < 9 cm dbh and/or ≥ 5 m tall. Within the subcanopy plot the diameter at breast height of all subcanopy trees will be measured and these trees will be identified to species.

The **Shrub Plot** is a circular plot of 5m radius that will be randomly placed within the sampled zone using a spin of the compass to determine bearing and a random number table to determine paces. The shrub layer is defined as being ≥ 1 m and < 5 m tall. Within the shrub plot stem density will be estimated by tallying the number of woody stems.

CANOPY CLOSURE: Canopy closure will be measured using 20 ocular tube readings which will be paced along cardinal bearing transects. Each plot will be separated by two paces and there will be 5 readings along each cardinal transect.

GROUND COVER AND DEPTH OF DUFF LAYER: Percent **ground cover** will be estimated within 10 1m² plots. **Depth of duff layer** will be measured at the center of each 1m² ground cover plot using a ruler. These ground cover plots will be established along the cardinal transects and will correspond to every other canopy closure plot.

COARSE WOODY DEBRIS: A qualitative assessment of coarse woody debris (CWD), both snags and dead and down material, will be derived following a meander through the sampled zone. Three classes will be used to assess CWD. **Class 1:** CWD is absent or limited to small diameter stems (< 20 cm) and early successional species. **Class 2:** Moderate levels of CWD with trees ranging in dbh from 20-50cm; shade intolerant, mid-tolerant, and tolerant species represented in CWD; and/or range of decay classes from 1-5. **Class 3:** High levels of CWD with trees > 50 cm well represented; diversity of species represented with shade tolerant species being most prevalent; and range of decay classes from 1-5.

Additional Notes: _____

