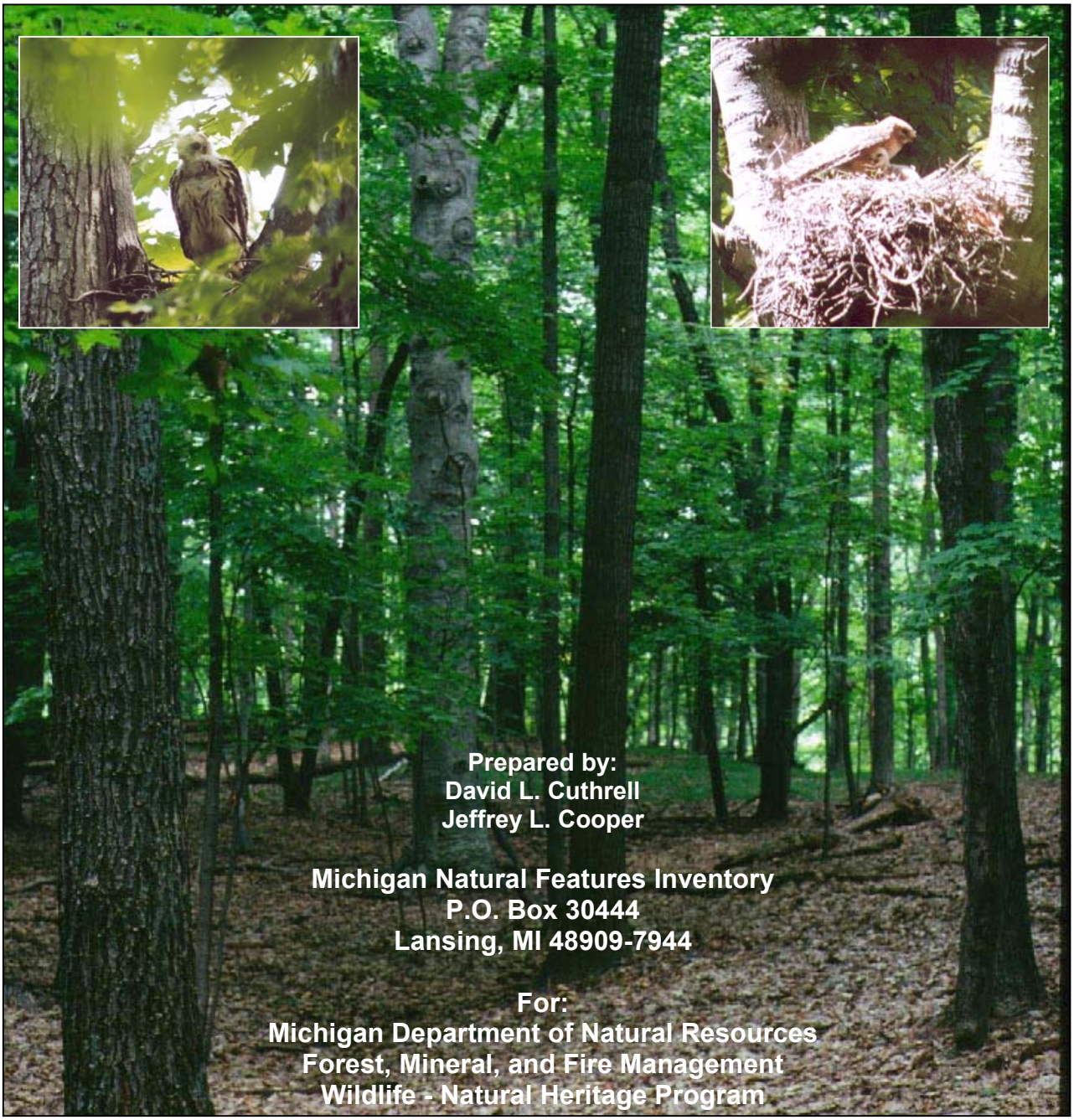
Red-shouldered Hawk Productivity, Landscape Analysis, and Nest Site Selection on State Forest Lands in Northern Michigan: Year 2001 Report



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Cover Photo Identification and Credits:

Top left: Immature red-shouldered hawk, Traverse City Forest Area, June 2000, by David L. Cuthrell

Top Right: Adult female shading young chicks from the sun, Indian River Forest Area, June 2001, by David L. Cuthrell

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ABSTRACT

In the early part of the 20th century the red-shouldered hawk (*Buteo lineatus*) was a common bird in southern Michigan. Since then its breeding range may have shifted from southern Michigan to the Northern Lower Peninsula (NLP). Currently the red-shouldered hawk is listed as state threatened in Michigan. We conducted systematic surveys for the red-shouldered hawk in seven state forest areas (Pigeon River, Indian River, Gaylord, Traverse City, Gladwin, Newberry, and Naubinway). A total of 118 compartments were intensively surveyed during a four year period (1998 – 2001). Nest productivity surveys were also conducted over a four year period to assess the reproductive success of populations in Michigan's NLP. Nearly 150 nests were assessed for nest productivity measures such as, nest-site fidelity, nest success, average brood size, and nest predation rates. We also analyzed habitat at the landscape, local site, and nest tree levels for nest sites and random points.

For areas surveyed over the four year study period, we found that nesting territories had a high re-occupancy rate (79%). Further, territories tended to be evenly distributed in areas that contained large contiguous tracts of suitable habitat with a nest every 1.5 km ($\pm$ 0.26 km). Nest productivity during this study tended on average to be high (72% successful nests) and brood size averaged 2.2 young per successful nest. Nest predation rates were fairly low with 17% of nests being depredated. Our habitat analysis indicated that nests typically were located within a heavily forested landscape (71% forest cover $\pm$ 3%), primarily composed of upland deciduous forests (53% upland deciduous forest cover $\pm$ 6%). Nests were typically located in northern hardwood stands with well-stocked pole or saw timber (90.2% of all nests documented). Nests also tended to be located near wetlands (80% within 0.4 km) and upland openings (mean distance to upland opening 181 m $\pm$ 46 m).

Our data indicate that nest trees tended to be deciduous, primarily beech, however any tree with the right structure, i.e., a multi-pronged crotch, could be suitable. Nests tended to be placed in large, mature, super-canopy trees and the nest itself was placed on average 14.1 m $\pm$ 0.37 m above the ground. At the local site level, canopy height, basal area, tree density, canopy closure, and average tree diameter at breast height (dbh) appear important in nest selection. By utilizing both a landscape and micro nest site approach, insight on distribution and habitat use can be gained which will facilitate sound management of this species. Information from this study is also being used to assess abundance and distribution, which will help determine the appropriate state listing status for this raptor species.

INTRODUCTION

The red-shouldered hawk (*Buteo lineatus*) is currently listed as a state threatened species in Michigan. Historically it was considered one of the most common diurnal raptors in the Southern Lower Peninsula (SLP) (Barrows 1912). However, by the mid-1900's this species had become uncommon in southern Michigan. Population declines have been primarily attributed to loss of forest and wetland habitats. Presumably, as a result of habitat loss, populations shifted their breeding range from southern Michigan to the more forested portions of the state in the Northern Lower Peninsula (NLP) (Brewer et al. 1991). Currently, there are two primary sources of

distributional information concerning this species in Michigan. These include the Breeding Bird Atlas with 119 confirmed nests documented during the 1980's (Brewer et al. 1991), and the Michigan Natural Features Inventory's Biological Conservation Database with ~ 250 confirmed nests documented since the early 1980's (Natural Heritage Biological and Conservation Data System 2001). Distributional patterns from each of these databases mirror each other rather closely. Two distinct population clusters are evident, one centered in the NLP, including Emmet and Cheboygan counties, and the other centered in the Manistee County area. Only scattered occurrences of confirmed red-shouldered hawk nests occur in the SLP and the Upper Peninsula (see special animal abstract in Appendix VI).

This species is a woodland raptor that requires forested landscapes composed of deciduous or mixed forests. The proto-typical habitat for this species is mature forested floodplains (Johnsgard 1990). Upland hardwood systems are also utilized when wetland complexes are juxtaposed or interspersed among them (Craighead and Craighead 1969, Postupalsky 1980, Bednarz and Dinsmore 1981, Cooper et al. 1999, Cooper and Cuthrell 2000). In Michigan this species has been most frequently documented in hardwood stands composed of well stocked pole or saw timber, particularly hardwood complexes with associated wetland habitats. Birds have also been documented in older aspen stands (A6/9), lowland poplar stands (P6), cedar swamps (C6/9), lowland conifers (Q6/9), and occasionally in pine communities (W8/9) (Cooper et al. 1999). Red-shouldered hawks are strongly associated with wetlands and the core of a breeding pair's territory typically encompasses wetland habitat. Wetlands such as beaver ponds, wet meadows, and lowland forests are utilized primarily for foraging purposes (Howell and Chapman 1997). Small upland openings are also used to some extent for foraging habitat (Evers 1994). Red-shouldered hawks typically nest in stands of timber with greater than 70% canopy closure (Bryant 1986) and relatively open understories (Evers 1994). Nests are most frequently placed high (usually just below the canopy) in mature deciduous trees and within close proximity of wetland habitat (Titus and Mosher 1981, Woodfry 1986, Ebbers 1986, Cooper et al. 1999). Mature maple, beech, birch, and aspen are frequently used nest trees in Michigan (Ebbers 1989, Cooper et al. 1999). However, any tree species with the appropriate structure (i.e., a multi-pronged crotch just below the canopy) can be utilized.

Purpose of the Inventory

Currently, there is a lack of information on this species' distribution and productivity in Michigan, including state forest lands. In addition, the impacts of forest management practices on habitat use and nest productivity have not been evaluated. This project, which will culminate in 2003, entails systematic surveys on state forest lands, reconfirmation of historical nest sites, and monitoring productivity on a representative subset of nest sites in each state forest area (see Appendix I for five-year work plan, revisions in workplan are highlighted in red). Information gathered from surveys and nest monitoring will be used to identify core areas of nest site concentrations on state forest lands, identify areas that support long-term population viability, and facilitate development of management guidelines. Further, this project, coupled with other related inventories (e.g., red-shouldered hawk inventories on state parks lands, natural areas, national forest lands, and state game areas) should facilitate assessment of the appropriate state listing status. This report focuses on the first four years of a six year study and includes an assessment of territorial re-occupancy, nest site re-occupancy, and nest productivity. In addition, habitat data at the landscape and micro habitat scales from confirmed nest sites and random points are included in this report.

METHODS

Establishment of Calling Stations

Surveys were conducted from early April – mid-May of 1998 - 2001. High priority forest compartments at the Pigeon River Country (PRC) Forest Management Unit, the Indian River (IR) area of the Gaylord Forest Management Unit, the Gaylord South Management Unit (GA), and the Traverse City Forest Management Unit (TC) were intensively surveyed for red-shouldered hawks. In addition, portions of high priority forest compartments in the Gladwin Forest Management Unit (GL), Naubinway Forest Management Unit (NA) and Newberry Forest Management Unit (NE) were surveyed for red-shouldered hawks. Surveys in the GL, NA, and NE Forest Management Units will continue in 2002, since large areas of high quality habitat are still in need of survey. Large deciduous or mixed forest complexes composed of medium to well stocked pole or saw timber (stocking density 5/6, or 8/9) with wetland habitats juxtaposed or interspersed among them were targeted for surveys. Also, select coniferous forest communities, both wetland and upland, that had a deciduous component and associated wetland habitat were surveyed as well (see Appendix II for cover types surveyed). These types of forest/wetland complexes were delineated by analyzing forest operational inventory (OI) maps, USGS topographical maps, 1978 current land cover maps, 1998 air photos, and by consulting with Michigan Department of Natural Resources (MDNR) Forest, Mineral and Fire Management (FMFM) and Wildlife personnel. Transects were placed every ¼ mile through forest habitats within compartments selected for surveys. Along each respective transect a calling station was placed every ¼ mile. At each calling station a taped conspecific red-shouldered hawk call was broadcast with a predator caller three times: at 60 degrees for 10 seconds, 180 degrees for 10 seconds, and 300 degrees for 10 seconds. This was followed by 30 seconds of listening. This calling sequence was repeated three times at each calling station. When hawks responded to the taped calls, observers intensively searched for birds and/or a nest in the direction the call was initially heard (Kennedy and Stahlecker 1993, Bowerman pers. comm.). In addition, 2-3 random calling stations were established per compartment surveyed and the same calling sequence mentioned above was utilized. Random calling stations were added to surveys during 1999-2001 for future statistical comparisons in order to differentiate habitat patterns around nest sites from habitat patterns that occur throughout the larger landscape (Moritz, pers. comm.). Currently, over 100 random points have been surveyed in northern Michigan forest areas. Raptor nest reporting forms (Appendix III) were filled out at each survey site and random point. Confirmed nest locations from 2001 were recorded using Garmin GPS units. Nest locations were then loaded into Arc View and records were transcribed and entered into the Michigan Natural Features Inventory's Biological Conservation Database.

Productivity Surveys

During early June of 1998 - 2001, a representative subset of active nests were re-visited at least once to assess productivity. Only those nests where incubation was confirmed during April surveys were considered active. Surveys were timed during the later part of nestling stage, usually within a couple weeks of fledging, because young birds are more conspicuous at this time. Two methods were used to assess productivity. These included on-the-ground surveys where the nest is observed from a vantage point or the base of the nest tree is inspected for white wash. A second more definitive method was looking into the nest with a mirror attached to a 15 m (50 ft) pole. A nest was considered successful if at

least one young 80% of the fledgling age was produced (Kochert 1986).

Habitat Structure

Landscape Scale

Habitat data around nest locations documented at the PRC and IR were summarized by utilization of 1998 air photos, OI maps, USGS topographical maps, 1978 current land cover maps, and some limited ground truthing. The percentage of nests occurring in the following categories was calculated: cover type (OI designations), location in upland or lowland, proximity to wetland, distance to nearest upland opening, and stocking density/size class (OI designations). The percent cover of habitat types (Table 1) around nest sites (n=51) and random points (n=48) were calculated by centering the nest site within a 1.8 km x 1.8 km (1 mi x1mi) quadrat (Ebbers 1989, Bowerman pers. comm.). The percent cover of each habitat type was estimated by laying a film transparency grid over the quadrat and counting the number of intersects per habitat type within the grid. The number of intersects per habitat type was divided by the total number of intersects per grid (n = 361) to calculate percent cover per nest site and random point. Percent cover for nest sites and random points were expressed as a mean percent and 95% confidence intervals for each mean percent were calculated as well. Each respective cover type was delineated by utilizing 1998 air photos and OI maps. Distance to wetland habitat and upland openings were measured in the field by pacing if distances were less than 200 m. If distances were greater than 200 m, measurements were derived from 1998 air photos by utilizing a parallax wedge. Landscape scale data are still being analyzed for nests located in the five other state forest areas.

Table 1. Description of landscape-level attributes.

Variable	Definition
% Forest	Forest cover included deciduous or coniferous cover that was composed of pole or saw timber
% Open	Open area included grassland, seedling stands, clear-cuts, lowland brush, upland brush, and open water
% Upland Deciduous Forest	Upland deciduous forest included all forest communities dominated (> 50%) by deciduous trees in upland habitat
% Wetland Deciduous Forest	Wetland deciduous forest included all forest communities dominated (> 50%) by deciduous trees in wet habitat
% Upland Conifer Forest	Upland conifer forest included all forest communities dominated (> 50%) by coniferous trees in upland habitat
% Lowland Conifer Forest	Lowland conifer forest included all forest communities dominated (> 50%) by coniferous trees in wetland habitat
% Open Water	Open water included lakes, ponds, and impoundments of water
% Wetland Opening	Wetland openings included marsh and lowland brush

Nest Site Variables

Various habitat attributes were summarized during August 2000 and August 2001 for 44 nest sites and 35 random points by centering the nest site in a 0.04 ha (1/10 ac.) plot. These variables included (Trexel et al. 1999):

1) **Nest tree diameter breast height (DBH):** Diameter (cm) at breast height of nest tree.
2) **Nest tree height:** Height (m) of the nest tree estimated by use of a clinometer.
3) **Nest percentage:** Nest height/tree height X 100.
4) **Canopy height:** Mean height, from the forest floor to the lower portion of the canopy, from five randomly chosen trees within plot.
5) **Canopy closure:** The percentage of the area over the plot occluded by overstory foliage, measured by 40 ocular tube readings.
6) **Ground cover:** The percentage of the ground covered by ground-layer foliage. This was measured by systematically placing 10 sampling points radiating from the nest tree in each of the four cardinal directions. Ground cover was measured by placing a meter stick vertically to the ground every meter along the transect line. When vegetation contacted the front edge of the stick it was counted as a hit. Total ground cover was calculated as the total number of hits/total number of points X 100.
7) **Sapling density:** The number of woody stems greater than shoulder height and less that 12.7 cm DBH and contained within ½ of the 0.04ha plot.
8) **Shrub density:** The number of low shrubs < 12.7 cm DBH and shorter than shoulder height contained within ¼ of the plot.
9) **Tree density:** The number of trees $\geq$ 15 cm DBH per 0.04 ha plot.
10) **Basal area:** m^2/ha trees.
11) **Mean DBH:** Mean DBH (cm) of trees in study plot.

RESULTS AND DISCUSSION

Compartments Surveyed

A total of 40 PRC, 25 IR, 16 GA, 9 TC, 14 GL, 12 NA, and 2 NE compartments (118 total) were systematically surveyed during 1998 – 2001 (Appendix II). In addition, over 100 random points were surveyed in compartments that were systematically surveyed. The majority of compartments containing high quality habitat (i.e., large deciduous or mixed, pole/saw timber complexes juxtaposed or interspersed with wetland habitat) in the PRC, IR and GA areas have been surveyed at least one time. However, large areas of high quality habitat within the NA, NE, and GL Forest Management Units have not been surveyed but are slated for systematic surveys during 2002. Since the amount of suitable habitat within each compartment varied, some compartments were more intensively surveyed than others. Further, a wide range of cover types of varying stocking densities were intensively surveyed for red-shouldered hawks (Appendix II). Varying landscape positions, such as very dry upland forest (up to a mile from wetland habitat) and wet lowland forest, were systematically surveyed as well. A few habitat types were under represented during surveys and these included red pine stands, white pine stands, and lowland conifers (Q and C types). These habitat types are not typically exploited by red-shouldered hawks for nesting purposes (Johnsgard 1990). However, lowland conifer and white pine

stands with a deciduous tree component could provide good nesting habitat for red-shouldered hawks and these habitats will be more intensively surveyed in the future.

Systematic inventories were not conducted at the PRC, IR, or GA during 2000 or 2001 and only a representative sub-set of territories were monitored (PRC = 37 territories monitored and IR 16 territories monitored). This accounts for lower numbers of active territories being documented during 2000 and 2001 than in previous years when the PRC and IR were intensively surveyed for new nests and territories (Table 2).

Territory Activity

A total of 38 active territories (i.e., area where hawks were heard or had a freshly tended nest) were documented during 1998, 105 active territories during 1999, 80 active territories during 2000 and 81 territories during 2001 surveys. (Table 2). Among theses active territories, 28 active nests (i.e., where incubation was confirmed) were located during 1998, 39 during 1999, 26 during 2000, and 55 during 2001 for a total of 148 nest sites found between 1998-2001. No nests were found near random points. The number of active territories and nests varied annually and by Forest Management Unit (Table 2). Survey and monitoring efforts in the GA and PRC were hampered during 2000 due to cold temperatures and high winds. Poor weather conditions, particularly high winds, tend to decrease avian activity in general (Bibby et al. 1992) as well as red-shouldered hawk response rates to conspecific calls. The result was most likely a lower detection rate of territorial and nesting birds at the GA and PRC Forest Management Units during that particular year.

Territorial re-occupancy (i.e., territories occupied during successive years) was high among all forest areas (Table 2). During 1999, 78% of the territories documented during 1998 (n=27) were re-occupied, 81% of the territories documented during 1999 (n=52) were re-occupied by territorial hawks during 2000, 78 % of the territories documented during 2000 were re-occupied by territorial hawks during 2001 (n=60). The overall re-occupancy rate of territories during successive years of the study has been high (79%) (Table 2). Jacobs and Jacobs (1997) reported that an 83% re-occupancy rate (range = 53% - 83%) was the highest they have documented in Wisconsin between the years of 1992 – 1997. The percentage of territories re-occupied between 1998 and 2001 in Northern Michigan forest management units compares rather well to the high re-occupancy rate documented by Jacobs and Jacobs (1997).

Nest site fidelity, which occurs when a pair utilizes the same nest as the previous year, was high as well during 1999-2001 (Table 2). Fifty percent of the nests utilized in each forest area during 1998 were re-occupied during 1999, 60% of nests utilized during 1999 were used as nest structures in 2000, and 67% of nests used during 2000 were used again in 2001, for a three year average of 59%. Johnsgard (1990) felt that a nest re-occupancy rate of 37%, which was documented by Jacobs et al. (1988) in Wisconsin, was high. Dijak et al. (1990) in Missouri found a 35% re-occupancy of nests in successive years, which is similar to the rate reported in Wisconsin. Nest site fidelity in Michigan state forests clearly exceeds rates documented in Wisconsin and Missouri.

At the PRC, known active nest sites were distributed rather evenly throughout large contiguous hardwood/wetland complexes during 1999. The average distance between nests within these complexes was 1.5 km $\pm$ 0.26 km (0.93 mi $\pm$ 0.16 mi). In large contiguous areas of suitable habitat in Maryland and Georgia, the average distance between nest sites was 2.1 km and 2.0 km, respectively (Stewart 1949, Howell and Chapman 1997). Uniform nest site spacing is a phenomenon that typically happens in large contiguous areas of suitable nesting habitat in order to abate territorial overlap, thus reducing interference in breeding and hunting among pairs

(Howell and Chapman 1997). This phenomenon was evident in the PRC during this study, which suggests that large areas of the PRC Forest Management Unit offer suitable nesting habitat for the red-shouldered hawk, provided sufficient prey base is available in a given year. Uniform nest spacing at the other state forest areas was not as apparent (however data analysis is still being conducted and will be reported on in the final project report). This could be attributed to differences in landscape composition. Also, fragmented ownership patterns did not allow entire forest complexes to be surveyed due to private in-holdings.

Nest Productivity

A representative sub-set of the nests, documented during this study, were re-visited during June, 1998 - 2001 (Table 3). Nest productivity among northern Michigan forest areas surveyed was high (73% successful) (Table 3). Average brood size (number of young per successful nest), from nest site data combined for all forest areas between the years of 1998 - 2001 was 2.2 young per successful nest (n=56) (Table 3).

Nest predation was confirmed (e.g., claw marks on trees, den tree nearby, nests torn apart, remains of adult hawk, etc.) for 17% of occupied nests between 1998 – 2001 (Table 3). The primary nest predator implicated was the raccoon (*Procyon lotor*) and great-horned owl (*Bubo virginianus*). Five adult red-shouldered hawks were killed during 2000 and 5 were killed during 2001 on or near the nest. These deaths were most likely the result of predation by great-horned owls. Jacobs and Jacobs (1997) and Ebbers (1989) also documented the raccoon and great-horned owl as primary predators of red-shouldered hawks in Wisconsin and Michigan, respectively.

Nest success rates were high over the past four years and compare rather favorably with other studies concerning this species (Table 4). However, wide variations in nesting success rates can occur annually (Jacobs and Jacobs 1997, Stavers et al. 1995, and Henny et al. 1973). Monitoring of nest success rates at all forest areas only spans a four year period and varied somewhat between years. Therefore, in order to fully assess population viability at northern Michigan state forest areas, monitoring will need to continue over the next several years. Monitoring of nest sites is tentatively planned until 2003. Henny et al. (1973) felt that a recruitment rate of 1.95 young per active nest with at least 77% of all nesting attempts being successful was needed to replace annual mortality. Jacobs and Jacobs (1998) argued that Henny's model was biased too high due to a small sample size and large variation in the range of recruitment rates among years. Jacobs and Jacobs (1998) analyzed productivity data from Wisconsin using a computer population model (PD: Population Dynamics Modeling, Version 4.0 C 1989 by J.W. Grier, Zoology Dept. ND State Univ., Fargo, ND). From this model they estimated that a recruitment rate of 1.4 young per active nest with over 50% of nesting attempts being successful was needed to replace annual mortality (Jacobs pers. comm.). Recruitment rates and nest success during this study either met or exceeded Jacobs and Jacobs estimates. This may suggest that over the past four years red-shouldered hawk recruitment has exceeded annual mortality and the population in the study area may have produced a surplus of birds.

The results from this study are counter to results obtained by Ebbers (1989) who documented a moderate nest success rate (56.8% nest success) and low numbers of young produced per active nest (1.2 young per active nest). In fact, Ebbers felt that the red-shouldered hawk population in the Straits region functioned as a population "sink" (i.e., annual mortality was greater than annual recruitment) and that the population in the Manistee County area functioned as a "source" population (annual recruitment was greater than annual mortality). Our study suggests that the red-shouldered hawk population in the Straits region between the years of 1998 – 2001

Table 2. Breeding territory activity at seven northern Michigan state forest areas (1998 –2001).

Reproductive Variable	Pigeon River	Indian River	Gaylord	Traverse City	Gladwin	Eastern UP[a]	Overall
Number of Territories[1]	**1998** - 21	**1998** - 17	**1998** - NA	**1998** - NA	**1998** - NA	**1998** - NA	**1998** - 38
	1999 - 49	**1999** - 30	**1999** - 18	**1999** - 8	**1999** - NA	**1999** - NA	**1999** - 105
	2000 - 22	**2000** - 17	**2000** - 18	**2000** - 23	**2000** - NA	**2000** - NA	**2000** - 80
	2001 - 22	**2001** - 16	**2000** - 15	**2001** - 15	**2001** - 5	**2001** - 6	**2001** - 79
Territories Reoccupied [2]	**1999**- 14 /19 (74%)	**1999** - 7 / 8 (88%)	**1999** - NA	**1999** - NA	**1999** - NA	**1999** - NA	**1999** - 21 /27 (78%)
	2000 - 22/ 27 (59%)	**2000** - 12 /16 (75%)	**2000** - 6/7 (86%)	**2000** - 2/ 2 (100%)	**2000** - NA	**2000** - NA	**2000** - 42 /52 (81%)
	2001 - 17/20 (85%)	**2001** - 12/ 17 (71%)	**2001** - 7/9 (78%)	**2001** - 11/14 (79%)	**2001** - NA	**2001** - NA	**2001** - 47/60 (78%)
New Nests [3]	**1998** - 19	**1998** - 9	**1998** – NA	**1998** – NA	**1998** - NA	**1998** - NA	**1998** - 28
	1999 - 18	**1999** - 8	**1999** – 8	**1999** – 5	**1999** - NA	**1999** - NA	**1999** - 39
	2000 - 7	**2000** - 4	**2000** - 4	**2000** - 11	**2000** - NA	**2000** - NA	**2000** - 26
	2001 - 0	**2001** - 5	**2001** - 7	**2001** - 2	**2001** - 3	**2001** - 4	**2001** - 21
							4-year total - 114
Nest Site Fidelity [4]	**1999** - 9 /18 (50%)	**1999** - 4 / 8 (50%)	**1999** - NA	**1999** - NA	**1999** - NA	**1999** - NA	**1999** - 13/ 26 (50%)
	2000 - 8/14 (57%)	**2000** - 5/7 (71%)	**2000** - 0/2 (0%)	**2000** - 2/2 (100%)	**2000** - NA	**2000** - NA	**2000** - 15/25 (60%)
	2001 - 13/17 (76%)	**2001** - 6/10 (60%)	**2001** - 6/7 (86%)	**2001** - 5/11 (45%)	**2001** - NA	**2001** - NA	**2001** - 30/45 (67%)
							Average - (59%)

[a] Includes both Naubinway and Newberry State Forest Management Units

[1] Areas where red-shouldered hawks were observed, heard, or had a freshly tended nest during the breeding season.
[2] The percentage of territories re-utilized during successive years.
[3] The number of newly discovered active hawk nests.
[4] The percentage of nests re-utilized during successive years.

Table 3. Productivity of red-shouldered hawk nests at seven northern Michigan state forest areas (1998 – 2001).

Reproductive Variable	Pigeon River	Indian River	Gaylord	Traverse City	Gladwin	Eastern UP[a]	Overall
Percentage of Successful Nests [1]	**1998** - 8 /13 (62%) **1999** - 16 / 21 (76%) **2000** - 10/16 (63%) **2001** - 12/17 (70%)	**1998**- 5 /7 (71%) **1999** - 9 /9 (100%) **2000** - 7/9 (78%) **2001** - 7/12 (58%)	**1998** - NA **1999** - 3/4 (75%) **2000** - 2/4 (50%) **2001** - 7/10(70%)	**1998** - NA **1999** - NA **2000** - 5/6 (83%) **2001** - 9/10 (90%)	 **2001** - 2/3 (66%)	 **2001** - 2/4 (50%)	**1998** - 13 /20 (65%) **1999** - 28 /34 (82%) **2000** - 24/35 (69%) **2001** - 39/56 (70%)
Number of Young per Successful Nest [2]	**1999** - 2.3 (n=7) **2000** - 1.7 (n=3) **2001** - 2.1 (n=12)	**1999** - 2.3 (n=3) **2000** - 2.5 (n=7) **2001** - 2.4 (n=5)	**1999** - 2 (n=1) **2000** - 2.0 (n=1) **2001** - 2.0 (n=6)	**1999** – NA **2000** – 2.0 (n=4) **2001** - 2.14 (n=7)	 **2001** - 2 (n=1)	 **2001** - 2 (n=2)	**1999** - 2.36 (n=11) **2000** - 2.1 (n=12) **2001** - 2.12 (n=33)
Number of Young Per Active Nest[3]	**2001 -** 1.35 (n=17)	**2001 -** 1.25 (n=12)	**2001 -** 1.40 (n=10)	**2001 -** 1.8 (n=10)	**2001 -** 1.33 (n=3)	**2001 -** 1.00 (n=1.00)	**2001 -** 1.40 (n=56)
Predation Rates [4]	**1998** - 3 /13 (23%) **1999** - 3 /21 (14%) **2000** - 5/16 (31%) **2001** - 3/17 (18%)	**1998** - 1 /7 (14%) **1999** - 0 / 9 (0%) **2000** - 2/9 (22%) **2001** - 1/11 (9%)	**1998** - NA **1999** - 1/4 (25%) **2000** - 2/4 (50%) **2001** - 2/10 (20%)	**1998** - NA **1999** - NA **2000** - 1/6 (17%) **2001** - 0/10 (0%)	 **2001** - 0/3 (0%)	 **2001** - 0/4 (0%)	**1998** - 4 /20 (20%) **1999** - 4 /34 (12%) **2000** - 10/35 (29%) **2001** - 6/55 (11%)

[a] Includes both Naubinway and Newberry State Forest Management Units.

[1] The percentage of nests with $\geq$ 1 young produced to 80% of the fledgling age (4 – 4.5 weeks old)
[2] The average number of nestlings 80% of the fledgling age per successful nest
[3] The average number of nestlings 80% of the fledgling age per active nest (this number is conservative as we did not climb the nest tree)
[4] The percentage of nests that were destroyed by a nest predator

Table 4. Comparison of red-shouldered hawk nest success rate at seven northern Michigan state forest areas with eight other studies.

Location	No. Nests Studied	% of Nests Successful	No. Young Fledged / Active Nest	Source
Southern California	29	66	1.34	Wiley 1975
Central and ne. Wisconsin 1990-97	557	51	1.13	Jacobs and Jacobs 2000
Central Maryland	74	68	1.58	Henny et al. 1973
Southern Ontario	6	83	1.80	Armstrong and Euler 1982
Iowa	8	88	2.90	Bednarz 1979
Northern Michigan 1986-1988	44	57	1.20	Ebbers 1989
Northern Michigan 2001	**56**	**70**	**1.40**	**This report**
Southern Michigan	61	-	1.80	Craighead and Craighead 1969
Western Maryland	17	53	1.80	Janik and Mosher 1982

may have been functioning as a source population and not a sink. The reason nest nest success and recruitment rates differed between Ebbers study and this study is probably due to multiple reasons, many of which may never be fully understood. One explanation for these differences may be due to weather. Jacobs and Jacobs (1997) and Newton (1979) felt that weather and prey availability can influence nesting success in multiple ways. During mild weather, prey base (e.g., small mammals, frogs, snakes, etc.) most likely is higher and red-shouldered hawks have more to feed their broods, which leads to higher reproductive success. Also, if prey base is high, predators probably exploit these animals as a food resource rather than killing red-shouldered hawks (Jacobs and Jacobs 1997). During the four years that surveys were conducted on state forest lands, particularly during 1999, winters were very mild and spring weather began earlier than normal. During Ebbers study weather may have been more severe and the winter weather may have lasted longer. Therefore, mild weather conditions during this study may have produced a greater prey base, which may have reduced the rates of predation on red-shouldered hawk nests, and increased food availability, and ultimately increased nesting success. Other reasons for different estimates of nest success and recruitment rates between this study and Ebbers' study include differences in survey methodology, maturation of forests, changing habitat structure, differences in sample sizes between studies (Table 4), and changes in the abundance of nest predators/competitors in the region. Continued monitoring of productivity over a period of several years within each forest area will provide a data set which should reveal factors that limit or enhance nest productivity.

Habitat Structure

One of the objectives of this study was to determine if red-shouldered hawks use select portions of the landscape for nesting habitat. Varying cover types (e.g., open habitat, deciduous forest, coniferous forest, etc.) and landscape positions such as very dry upland forest (up to a mile from wetland habitat) and wet lowland forest were extensively and systematically surveyed

among seven state forest areas over the past four years. A few habitat types were under represented during surveys including red pine stands, white pine stands, and lowland conifers (Q and C types). These habitat types are not believed to be typically exploited by red-shouldered hawks for nesting purposes (Johnsgard 1990). However, lowland conifer and white pine stands with a deciduous tree component could provide good nesting habitat for red-shouldered hawks. In addition over 100 random points among forest area compartments surveyed were sampled. No nest sites were found near random points (> 100 sampled). Occasionally a territorial bird responded to a conspecific call from a random point in habitat that was presumed to be inactive and not suitable for nesting. However, in virtually every case, observers followed the bird quite a distance from the random point into more "ideal" red-shouldered hawk habitat (e.g., deciduous/mixed forest near wetland habitat). These results indicate that red-shouldered hawks do not occur randomly on the landscape and that certain habitat attributes at the landscape and micro scales appear to influence selection of nesting habitat. Important attributes at both scales are discussed below.

Landscape Scale

Analysis of landscape-level attributes revealed some interesting patterns around nest sites. Fifty-one nest sites and 48 random points were analyzed for landscape composition. The majority of the landscape surrounding both nest sites and random points was largely forested (71% $\pm$ 3% forest cover and 66% $\pm$ 5% forest cover, respectively) (Table 5). However, nest sites tended to be located in more heavily forested portions of the landscape. In contrast, random points had larger percentages of open-land habitat (Table 5). Nest sites were also surrounded by greater percentages of upland deciduous forest than random points (53% $\pm$ 6% upland deciduous forest cover for nest sites and 45 % $\pm$ 7% upland deciduous forest cover for random points). Further, random points had a greater portion of the landscape composed of upland conifer forest than nest sites (11% $\pm$ 4% and 7% $\pm$ 3%, respectively). The percent cover of wetland deciduous forest, lowland conifers, and open water was quite variable and occurred in small percentages for both nest sites and random points (Table 5). Nest sites tended to be located very near wetland habitat and upland openings (Table 5). In comparison, random points had highly variable distances to both wetlands and upland openings (Table 5).

The vast majority of nest sites (79.3%) were located in northern hardwood stands. Stands of aspen, oak, lowland conifer, and white pine contained smaller percentages of nest sites (Table 5). Random points were located in northern hardwoods at much lower percentages (Table 5). The vast majority of nests (90.2%) were also located in well-stocked pole/saw timber stands. Nests were never located in poorly stocked pole timber stands or seedling stands and occurred in small percentages in poorly and medium stocked saw log stands (Table 5). Nests and random points occurred in the exact same percentages for upland and lowland habitat (Table 5).

Throughout the species' range, red-shouldered hawks are generally associated with floodplain forests (Evers 1994). However, Bednarz and Dinsmore (1981) found that red-shouldered hawks will use large, contiguous upland forest complexes, which may compensate for a lack of floodplain habitat. Postupalsky (1980) and Ebbers (1989) also documented red-shouldered hawks utilizing upland forest adjacent to wetland habitats in northern Michigan. In northern Michigan state forest areas, extensive tracts of mature floodplain forest are lacking. However, landscapes in these forest areas are composed of a complex matrix of upland forests and a variety of wetland habitats. Red-shouldered hawks in the forest areas studied appear to select more heavily forested portions of the landscapes for nesting habitat that contain dense stands of deciduous/mixed forest.

This is apparent when one compares nest sites to random points. Nest sites had higher percentages of forest cover and markedly higher percentages of upland deciduous forest cover. Random points had more open habitat and markedly higher percentage of upland conifer forest. Howell and Chapman (1997) and Johnsgard (1990) found that red-shouldered hawks nests tended to occur most frequently in forested landscapes composed of deciduous/mixed forest and tended to use coniferous forest sparingly. Results from this study concur with Howell and Chapman and Johnsgard's results. Nests also tended to be located in denser stands of timber (i.e., well stocked pole/saw timber) and were not found or occurred in smaller percentages in seedling stands and poorly to medium stocked pole/saw timber (Table 5). In contrast, random points occurred in all stocking classes, with the exception of classes 0 and 1 (Table 5). The percent of nests occurring in well stocked saw timber, when compared to random points, was considerably higher (40.2% and 15.0%, respectively). These results give credence to the theory that red-shouldered hawks prefer relatively mature stands of deciduous/mixed forest for nesting habitat. Preston et al. 1989 and Jacobs and Jacobs (1997) describe red-shouldered hawks as using relatively mature stands of timber for nesting.

Red-shouldered hawk nests also tended to be located very near wetland habitats (80 % within 463 m). The mean distance of nest sites to wetland habitat had a tight confidence interval (362 m $\pm$ 97 m), whereas the confidence interval for random points was quite variable (394 m $\pm$ 234 m) (Appendix IV). What this data suggests is that red-shouldered hawks prefer portions of the landscape near wetlands for nest placement. Random point distance to wetland habitat in the study area was quite variable. In a study in Georgia Howell and Chapman (1997) also found that red-shouldered hawks heavily exploit the ecotone between uplands and wetlands. The consistent documentation of nests near wetlands in our study follows habitat patterns noted by Howell and Chapman. Red-shouldered hawk nests also tended to be located close to upland openings and the confidence interval for the mean distance to upland openings was fairly tight (Table 5 and Appendix IV). In comparison, random points had a confidence interval for mean distance to upland opening that was quite large (Table 5 and Appendix IV). What this suggests is that red-shouldered hawks prefer to place nests near small upland openings. Boskowski and Smith (1997) found that red-shouldered hawks tended to place nests close to upland openings and wetlands as well.

Even though red-shouldered hawk nests tend to be relatively close to upland openings, it cannot be over emphasized that an increase in forest fragmentation (i.e., significant reduction in overall forest cover) across a landscape could likely result in an influx of nest competitors such as the red-tailed hawk (*Buteo jamaicensis*) and nest predators such as the great-horned owl. Both of these raptor species respond favorably to reduced forest cover (Bosakowski and Smith 1997), which could significantly inhibit red-shouldered hawk nesting success (Bryant 1986, Bosakowski and Smith 1997). Abatement of forest fragmentation can reduce the influx of nest predators and competitors. Currently, the red-tailed hawk population in the forest areas studied appears to be low, which is probably due to the heavy forest cover throughout the larger landscape. During the 1980's, Breeding Bird Atlas surveyors documented low to moderate numbers of red-tailed hawks in the current study area (Brewer et al. 1991). Furthermore, Ebbers (1989) also felt that red-tailed hawks were not a limiting factor in the forest areas surveyed. Great-horned owl abundance in the study area is likely low to moderate. Breeding Bird Atlas data from the 1980's indicates that great-horned owl numbers were low to moderate in the forest areas studied. However, in localized areas/sites this species may inhibit nest success of red-shouldered hawks. During 2000-2001 surveys, ten adult red-shouldered hawks

Table 5. Landscape-level attributes around red-shouldered hawk nest sites at the Pigeon River Country (PRC) and Indian River (IR) forest areas (1998 – 2001).

Landscape Variable	Nest Sites	Random Points
% Forest	71% ± 3% (n=51)	66% ± 5% (n = 48)
% Open Habitat	29% ± 3% (n=51)	34% ± 5% (n = 48)
% Upland Forest	53% ± 6% (n=51)	45% ± 7% (n = 48)
% Wetland Deciduous Forest	3% ± 2% (n=51)	2% ± 1% (n = 48)
% Upland Conifer Forest	7% ± 3% (n=51)	11% ± 4% (n = 48)
% Upland Opening	24% ± 1% (n=51)	27% ± 4% (n = 48)
% Lowland Conifer	8% ± 3% (n=51)	8% ± 2% (n = 48)
% Open Water	2% ± 2% (n=51)	1% ± 1% (n = 48)
% Wetland Opening	3% ± 1% (n=51)	6% ± 3% (n = 48)
Cover Type[1]	Northern Hardwoods - 79.3% (n = 82) Oak - 3.7% (n=82) Aspen - 6.1% (n=82) White Pine - 2.4% (n=82) Birch - 2.4% (n=82) Lowland Conifer - 2.4% (n=82) Cedar - 2.4% (n=82) Lowland Hardwood - 1.3 (n=82)	Northern Hardwoods - 26.5% (n = 48) Oak - 4.1% (n = 48) Aspen - 43% (n = 48) White Pine - 4.1% (n = 48) Birch - 2.0% (n = 48) Lowland Conifer - 6.1% (n = 48) Cedar - 4.1% (n = 48) Fir - 2.0% (n = 48) Grass - 2.0 (n = 48) Red Pine - 6.1% (n = 48)
Stocking Density/Size Class[2]	2 = 0% (n=82) 3 = 0% (n=82) 4 = 0% (n=82) 5 = 4.9% (n=82) 6 = 50% (n=82) 7 = 1.2% (n=82) 8 = 3.7% (n=82) 9 = 40.2% (n=82)	2 = 4.3% (n = 48) 3 = 19.1% (n = 48) 4 = 8.5% (n = 48) 5 = 8.5% (n = 48) 6 = 40.4% (n = 48) 7 = 2.1% (n = 48) 8 = 2.1% (n = 48) 9 = 15.0% (n = 48)
Location of Nest (upland or lowland)	85% Upland (n=82) 15% Lowland (n=82)	85% Upland (n = 48) 15% Lowland (n = 48)
Proximity to Upland Opening	181 m ± 46 (n=51)	231 m ± 184 m (n = 48)
Proximity to Wetland	362 m ± 97 m (n=51)	395 m ± 234 m (n = 48)

[1] The number of nests/random points, expressed as a percentage, occurring in a cover type.
[2] The number of nests/random points, expressed as a percentage, occurring in the following stocking density/size classes: 2 = medium stocked seedlings, 3 = well stocked seedlings, 4 = poorly stocked pole timber, 5 = medium stocked pole timber, 6 = well stocked pole timber, 7 = poorly stocked saw timber, 8 = medium stocked saw timber, and 9 = well stocked saw timber.

were killed on or near the nest during the incubation or during the brood rearing stage. Based on evidence at the nest site (i.e., remains of a plucked bird), great-horned owls were most likely the predator. Moreover, Ebbers (1989) felt that in northern Michigan great-horned owls may be a factor that limits nest success in localized areas.

Nest Site Variables

The majority of nests were placed in mature beech trees (41%); only a few nests occurred in conifers (2%) (Table 6). Apfelbaum and Seelbach (1983) examined 283 red-shouldered hawk nests nation-wide and found that 90% of nest trees were deciduous and the most commonly used genera were oaks (*Quercus* spp.) and beech (*Fagus* spp.). Beech trees frequently provide optimal structure (i.e., multi-pronged crotch just below the canopy) and the presence of mature beech trees in hardwood stands may be a very important micro-habitat factor that influences hawk utilization of nesting habitat (Ebbers 1989). However, the diversity of nest trees utilized in Michigan seems to indicate that tree structure and not tree species is the most important factor that influences use of a tree for nest placement. Nests were typically placed high (14.1 m $\pm$ 0.37 m) and within a multi-pronged crotch of the tree, which concurs with results obtained by Titus and Mosher (1981). Nest trees also tended to be mature, tall, super-canopy trees (height = 25.26 m $\pm$ 0.56 m, dbh = 50.1 cm $\pm$ 1.8 cm). Nest percent (the nest height divided by the overall tree height multiplied by 100) was 56%. In a northern Michigan study conducted by Ebbers (1989) and a study in Maryland (Titus and Mosher 1981), nests were usually placed between 10.6 m – 18.3 m above the ground and 1/2 – 2/3 the way up the nest tree. Results from this study mirror rather closely the descriptions of nest tree structure in northern Michigan and Maryland.

Forty-four plots (0.04 ha) around nest sites and 35 plots (0.04 ha) around random points were sampled for structural attributes (Table 7). Stands of timber that housed red-shouldered hawk nests had higher canopies than random points. Basal area, tree density, canopy closure, and average dbh per plot were greater around nest sites than random points. Ground cover, sapling density and shrub density were highly variable for both nest sites and random points (Table 7).

On average, stands of timber that housed red-shouldered hawk nests were taller and denser than random points and the 95% confidence interval for mean canopy height was rather narrow for nest sites and random points. This data may reflect red-shouldered hawks preferring taller stands of timber within forest complexes for nesting. Preston et al. (1989), Titus and Mosher (1981), and McLeod et al. (2000) also found that red-shouldered hawks prefer stands of timber with high canopies. Basal area around nest sites was high with little variation around the mean (Table 7, Appendix IV). In contrast, random points had a fairly high basal area but greater variation around the mean was evident (Table 7, Appendix IV). These results may suggest that red-shouldered hawks select stands of timber with higher basal areas and in un-occupied habitat basal area varies considerably. Kimmel and Fredrickson (1981), Portney and Dodge (1979), and Parker (1986) all found that red-shouldered hawks prefer stands of timber for nest placement that have high basal areas (99.5 ft^2 – 159 $ft.^2$). This study supports the results obtained by these researchers. Other nest site variables with tight confidence intervals that were greater than attributes at random points included tree density, canopy closure, and average dbh per plot. All of these variables suggest that red-shouldered hawks prefer the dense, relatively mature portions of forest complexes for nesting habitat. Further, these results are consistent with studies conducted by Ebbers (1989), Titus and Mosher (1981), and McLeod et al. (2000).

Table 6. Nest tree species utilized by red-shouldered hawk at seven northern Michigan state forest areas (1998 – 2001).

Tree Species	Percent Used (n = 130)
American Beech (*Fagus grandifolia*)	41%
Maple (*Acer spp.*)	21%
Aspen (*Populus* spp.)	12%
White birch (*Betula papyrifera*)	10%
Basswood (*Tilia americana*)	6%
White ash (*Fraxinus americana*)	3%
Red Oak (*Quercus rubra*)	2%
Yellow birch (*Betula lutea*)	2%
American Elm (*Ulmus americana*)	1%
Jack Pine (*Pinus banksiana*)	1%
White pine (*Pinus strobus*)	1%

Table 7. Red-shouldered hawk nest site characteristics at seven northern Michigan state forest areas (1998 – 2001).

Structural Attribute	Nest Site (n = 44)	Random Point (n = 35)
Nest Height	14.1 m $\pm$ 0.37 m (46.2 ft $\pm$ 1.2 ft)	NA
Nest Tree Height	25.26 m $\pm$ 0.56 m (82.9 ft $\pm$ 1.8 ft)	NA
Nest Percent	56.4% $\pm$ 1.5%	NA
Nest Tree dbh	50.1 cm $\pm$ 1.8 cm (19.7 in $\pm$ 0.7 in)	NA
Canopy Height	16.12 m $\pm$ 0.48 m (52.9 ft $\pm$ 1.6 ft)	11.89 $\pm$ 0.85 m (39.0 ft $\pm$ 2.8 ft)
Basal Area	11.1 m^2 $\pm$ 1.1 m^2 (123 ft^2 $\pm$ 12.7 ft^2)	9.8 m^2 $\pm$ 0.8 m^2 (109 ft^2 $\pm$ 9 ft^2)
Tree Density/0.04 plot	19.1 $\pm$ 1.1	15.8 $\pm$ 1.5
Sapling Density	62.8 $\pm$ 9.5	58.2 $\pm$ 9.3
Shrub Density	84.0 $\pm$ 13.7	71.8 $\pm$ 12.9
Canopy Closure	88.3% $\pm$ 1.2%	74.7% $\pm$ 4.5%
Average Tree dbh/0.04 plot	10.7 $\pm$ 0.22	9.4 $\pm$ 0.73
Ground Cover	42.3% $\pm$ 4.2%	49.8% $\pm$ 5.2%

CONCLUSIONS

Hawk surveys on northern Michigan state forest areas were highly successful and greater insight into habitat utilization and distribution patterns within each forest area was gained. Further, all reproductive parameters (i.e., territorial re-occupancy, nest site fidelity, nest success, brood size) compare favorably with other studies concerning this species. However, long-term trend data concerning productivity measures are needed to fully assess population viablity. The results from inventories and nest monitoring, at state forest areas studied, as well as future work in other Northern Lower and Upper Peninsula forest areas, should provide very valuable information. This information can be used to identify core areas of nest site

concentration that support long-term viability, facilitate development of management guidelines, assess the impacts of forest management practices on habitat use and productivity, and evaluate the hawk's status in Michigan.

FUTURE WORK

Over the next two years at least 20 representative nest sites (if available) on six forest areas in the NLP, and possibly several more in the UP, will be monitored for territorial re-occupancy, nest site fidelity, nest success, and brood size (Appendix I). Habitat parameters (landscape and micro-habitat scales) will continue to be quantified and summarized for all nest locations documented to date. Random point data was collected in all compartments surveyed and half of the random points (n = 48) sampled have had habitat parameters quantified and summarized at the landscape scale. Eighteen of the random points have been summarized and quantified at the micro-habitat scale. Data from random points will continue to be collected, summarized, and analyzed for current forest areas surveyed as well as areas to be surveyed over the next two years. Nest site data and random point data will be statistically compared to differentiate habitat patterns around nest sites from habitat patterns that occur throughout the larger landscape. Ultimately, habitat data from multiple scales will be used to develop a predictive habitat model to facilitate management decisions. Finally, by the end of this multi-year project, we hope to compare attributes around successful nests and unsuccessful nests to better evaluate efforts to enhance reproductive success.

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Appendix I

Red-shouldered hawk five-year work plan for surveys on state forest lands in Michigan

Forest Management Division

Red-shouldered Hawk 5-Year Work Plan

Statement of need

The Forest Management Division and Wildlife Division are jointly responsible for management of the State Forests for perpetuation of the resources of forest products, recreation and wildlife habitat. In addition, the Divisions are responsible for assuring that management activities do not harm threatened and endangered species. The red-shouldered hawk is a state threatened species for which concern has been expressed regarding impacts of management. Currently, there is a lack of information on this species' distribution and productivity on state forest lands as well as the impacts of forest management practices. This project will entail systematic surveys on state forest lands, reconfirmation of historic nest sites, and monitoring of productivity of a subset of nest sites in each state forest area. Information gathered from surveys and nest monitoring can be used to identify core areas of nest site concentrations on state forest lands, identify areas that support long-term viability, facilitate development of management guidelines, evaluate the appropriate state listing status, and assess the impacts of forest management on habitat use and nest productivity. This project continues the work of last year's highly successful systematic surveys of the Pigeon River and Indian River Forest Areas. These surveys resulted in identification of core areas of nest-site concentration, productivity of nests, and insights on habitat use. This information facilitated development of draft management guidelines by DNR's Woodland Raptor Working Group. Although the project initially does not specifically address assessment of management impacts we will be actively pursuing opportunities to incorporate this component into the study during subsequent years.

*** Changes from original workplan are highlighted in red. Changes were due to a variety of reasons including: a reduction in the proposed budget, larger amounts of suitable habitat in the study area than anticipated, as well as a greater number of nesting territories documented.**

Work Plan

Year 1

- Finish systematic surveys in the Pigeon River and Indian River Forest Areas.
- Re-check nesting areas documented during 1998 at the Pigeon River and Indian River Forest Areas.
- Systematically survey the South Gaylord Forest Management Unit
- Monitor 20 nests, or as many as available if less than 20 nests sites, in each forest area

Year 2

- Check nest territories documented during previous years in Pigeon River, Indian River, and S. Gaylord Management Unit to locate active nests
- Begin systematic surveys in the Traverse City Forest Management Unit and finish systematic surveys in the Gaylord South Forest Management Unit.
- Monitor 20 nests, or as many as available if less than 20 nest sites, in each forest area

Year 3

- Check nest territories documented during previous years in Pigeon River, Indian River, S. Gaylord, and Traverse City.
- Begin systematic surveys in the Gladwin Forest Management Unit, select areas in the UP, and finish systematic inventories in the Traverse City and Cadillac Forest Management Unit.
- Monitor 20 nests, or as many as available if less than 20 nest sites, in each forest area

Year 4

- Check nest territories documented during previous years in Pigeon River, Indian River, S. Gaylord, Traverse City, Cadillac, Gladwin, and the UP
- Begin systematic surveys in the Atlanta Forest Management Unit, select areas in the UP, and finish systematic inventories in the Gladwin Forest Management Unit.
- Monitor 20 nests, or as many as available if less than 20 nest sites, in each forest area

Year 5

- Check nest Territories documented during previous years in Pigeon River, Indian River, S. Gaylord. Traverse City, Cadillac, Gladwin, Atlanta, and the UP
- Finish systematic surveys in Atlanta and select areas of the UP
- Monitor 20 nests, or as many as available if less than 20 nest sites, in each forest area

APPENDIX II

Forest Compartments and stands surveyed for red-shouldered hawks at seven northern Michigan state forest areas (1998-2001).

The following table shows compartments and stands surveyed and habitat types targeted for surveys at the seven state forest areas 1998-2001.

Compartment Surveyed	Stands Surveyed	Habitat(s) Surveyed [1]
PRC-4	Special Management Unit	M9
PRC-6	10	A6
PRC-7	18, 43, 53, 59, 60, 61, 8, 56	A6, M6, M9, W6, A5
PRC-8	12	M9
PRC-9	5, 4, 1 15, 10, 22, 21, 20, 33, 31, 33, 39, 62, 46, 59, 51, 44	A6, E6, M6, M9, Q6
PRC-10	10, 5, 18, 21, 35, 34, 40, 44, 55, 58, 65, 25, 26	M6, A6, A2
PRC-11	52, 53, 50, 58, 22	M9, E6, A6, A9,A3
PRC-12	17, 22, 33, 51, 84	A6, M6, E6, A3
PRC-13	12, 2, 7, 6, 5, 18, 53	M6, M9,A3
PRC-14	1, 4, 31, 35, 37, 50, 47, 55, 59, 60	M9, M6, A5, E9
PRC-15	26, 60, 62, 46, 66, 75, 76, 73, 72, 71, 78, 77, 80, 53	E5, M6, M8, A6, P5, Q6, W6, E6,A3
PRC-16	52, 47, 44, 16, 40	M6, M8, M5, W8
PRC-17	13, 21, 23, 100, 62	M6, M9, M5, G, R9
PRC-18	45	M6/9
PRC-20	69, 41, 5, 8	M6, A6, C6, A0
PRC-21	58, 38, 14, 4, 58	A5, M6, E5, E6, R9
PRC-22	1, 17, 26, 7	M6/9
PRC-23	48, 67	A5, A6, M6, E5, O6, A3, F2
PRC-24	38, 40, 41, 34, 92, 85, 33, 47, 24, 21, 53, 56, 49, 50, 94	M6, E5, A5, B6, A4
PRC-26	13, 8, 25, 28	O9, M6
PRC-29	16, 12, 14	E6, M6
PRC-30	119, 30, 10, 8	M6/9
PRC-33	72, 74, 46, 36, 31, 29, 44, 27, 32, 18, 28, 21, 18, 9	A5, M6, M9, A3
PRC-35	21, 33, 20, 16, 29	M6, O9, M9, R6
PRC-37	9, 6, 7, 12, 14, 15, 51	M6, M8, M9, O8, M5, W8
PRC-39	21, 22, 56, 27, 28, 59, 38, 39, 2, 1	M6, O5, M9, B6, Q5
PRC-40	39	O7, A2, R8, W5/7
PRC-41	1, 39, 56, 62, 71, 9	A6, O6, M6, C6, W9, O7, T4
PRC-42	62, 57, 53, 38, 37, 35, 11, 30, 9, 6	A5, M5, M6, O5, R7, J5
PRC-43	24, 25	M8, W8, A2
PRC-46	36, 130	M6, Q6, W8, L
PRC-47	7, 4, 2, 17, 13, 15, 17, 22, 27, 23, 26, 28, 29, 30, 32, 39, 50, 56, 62, 64, 56, 57	O6, M6, M9, B6, O9, W9
PRC-48	14, 5, 1, 9, 19, 23, 34, 37, 35, 48, 44, 56, 37	A6, M6, O6, A1, Q4
PRC-49	21, 15, 6, 55	A5, J3
PRC-52	56, 41, 56	O6, M5, C4
PRC-53	60, 81, 56, 42, 39, 38, 37, 14, 11, 4	M5, M6, E5, A5, A6, M9,C6
PRC-54	1, 2, 19, 22, 7, 6, 5, 21, 25	M5, M8
PRC-55	6	M6
PRC-56	11, 10, 15, 16, 19, 22	A6, O6
PRC-57	30, 29, 26	M6
IR4	46, 40, 45, 47, 48, 21, 22, 23, 24, 26, 27, 13, 12, 11, 20, 14, 32, 54, 6, 7,	A6/9, M6/9
IR6	9, 24, 20	A5/66
IR15	19, 14, 5, 6, 13, 19, 29, 36, 44, 43, 33, 47, 46	M6/9, A6

Compartment	Stands Surveyed	Habitat(s) Surveyed [1]
IR16	2, 3, 5, 15, 9, 17, 10, 23, 44, 49, 41, 45, 11, 52, 55, 42, 39, 51	M6/9, A6
IR21	1, 22, 19, 23, 24, 26, 28, 30	M6/9, A5, A9, A3, W8, C6
IR22	3, 7, 11, 21, 19, 12, 15, 28, 7, 26	M6/9, W8, A3
IR30	17, 18, 21	E6, E8, B6
IR36	1, 3, 4, 13, 44, 47, 39, 23, 36, 28,	O6, A6, R6
IR39	4, 5, 2, 1	E6, M9, A9, A3
IR50	11	M9
IR57	117, 317, 417, 310,	M6
IR58	34, 37, 30, 29, 28, 27, 33, 35, 10, 4, 2, 3, 25, 21, 17, 44, 48, 46, 54, 55, 63, 60, 66, 59,l 67, 68	M6/9, P5, A6
IR59	6, 10, 1, 3, 13, 36, 37, 41, 38,	M6/9, E5
IR76	40, 7, 14, 39, 22, 39, 40,	A6/9, Q6, B6, P6
IR78	1, 11, 30,	A6/9, M6/9
IR82	2, 6, 9, 19	M6/9,
IR83	90, 84, 103, 86, 100	B6, M6, A5
IR88	3	M6
IR89	15, 8, 35, 235, 244, 38, 37, 28, 2, 1, 236, 36, 39, 139, 136,	M6/9, A6/9, B6, A3, G, C6, L
IR100	19 (Atlanta 174)	B6
IR106	18, 118, 1	E9, P6, A6, A3, J5
IR109	9, 12, 15, 18,19,	E9, A6/9, A4, R6
IR110	14	A6
IR111	33, 36, 31, 28, 29, 28,	A6, M6
IR153	60	A6
GA 34	47, 27,23, 18, 13	M6, A3, M9, G
GA 44	67, 73, 66, 24	A9, M9, M6, Q6
GA54	18, 15, 37	M6, Q6
GA 39	113, 222, 112, 111, 115, 114, 221, 110, 109, 223, 220, 107, 72, 119, 73, 47, 22, 1, 2, 5, 7, 24, 182	M6, E6, A6, E3, G, M9, A3
GA 40	23, 2, 9, 13, 50, 54, 56, 54, 72, 60	Q6, R9, M6, M8, M5, N
GA 41	30, 50, 24, 49, 26, 43, 21, 44, 52	A3, M6, G, O9, M9, M5
GA 50	8, 7, 10, 12, 20, 21, 22, 23, 34, 24, 37, 28, 26, 27	M9, M6, F6, M6, G, M5
GA 55	51, 42, 11, 43, 44, 18, 45, 4, 2, 35	G, M5, M7, M6, A3
GA 51	56, 50, 59, 51, 52, 49, 48	C3, A6, Q6, L, G, A3
GA 37	61, 63, 18, 67	C7, M8, M6, M7, Q9
GA 43	22, 19, 24, 27	M9, A3
GA 57	3, 7, 31, 36, 5, 11, 19, 15, 15, 35	Q6, A5, M6, G, A6, A5
GA 49	2, 39, 40, 3, 43, 7, 51, 4, 31, 33, 17	M6, M9, R2, U, A6
GA 48	10, 11, 6, 8, 24, 25, 32, 43, 44, 45, 46, 34, 26	M8, M6, M7, Q6, N, M4, G, A3
GA 47	1, 37, 2, 31, 41, 40, 13, 44, 14, 16, 23, 22, 18, 47, 33, 46, 27, 28	M5, M6, M7, M8, G, Q6, N, A3, C4, M4, L
GA 36	1, 52, 12, 54, 53, 17, 16, 15, 55, 3, 28, 27, 45, 46, 5, 3, 1, 61, 62,	A3, A6, G, R9, R6, A3, M5, M7, M9, M8
TC 34	4, 6, 8, 9, 100, 24, 29, 54, 42, 3, 83, 105, 60, 68, 41, 42, 43, 74, 33, 63, 75, 80	R6, A6, A3, M6, M9, M5, A3, G, E6, E9, E1
TC4	111, 40, 33, 44, 46, 85, 95, 91, 82, 94, 99, 101, 72, 70, 69, 64, 68, 63, 72, 98, 101, 90, 110, 107, 25, 19, 7, 103, 78	L, M9, M4, G, M6, A6, W7, M5, A4, M8, M5, M4, M8, W6, R6

Compartment	Stands Surveyed	Habitat(s) Surveyed [1]
TC 7	17, 10, 52, 16, 15, 53	M9, M6
TC 16	63, 113, 54, 57	M8, M9, M7, M6, A3
TC 49	86, 85, 95, 96, 93, 100, 8, 4, 30, 28, 66, 61, 51, 19	A3, C6, A4, E9, E6, M6, R6
TC39	23, 49, 22, 83, 3, 19, 20, 75	L, E6, G, W9, E7, E5, P3
TC9	3, 35, 36, 37, 39, 41, 3, 2, 11, 12, 15, 5, 21, 20, 22, 19, 25	M6, G, M9, A6, R6
TC36	115, 26, 25, 23, 18	E1, M9, Q6, W6, A6
TC35	34, 41	M6, W6
GL-5	100, 101, 116, 103, 120, 123, 122	A6, E8, E9, E2, A9, P6, O9
GL-124	8, 9	E8E6, O7
GL-127	9, 28, 26, 31	E6, A6
GL-115	65, 64	E9, A6
GL-113	38	O9
GL-12	25, 27, 22	O9, A6
GL-105	1, 11, 5, 101	E9, E5
GL-99	16, 22, 37, 38, 41, 48, 49, 52	A6, E6, O6, M6
GL-83	1, 5, 8, 16, 19, 20, 23, 27	M6, E6, A6, E9
GL-75	17, 21, 28, 67, 79	A6, A9, O6, E6
GL-63	3, 4, 5, 39	E9, E6, A3
GL-10	53, 94, 95	W7E6, E9, Q6
GL-125	42	E6
GL-96	Not numbered	A6
NAU-148	58, 59	M6, M9
NAU-168	33, 51	Q5, M6
NAU-197	75	M6
NAU-180	2, 3, 4, 10, 13, 18, 16	M9, M6, H9
NAU-137	34, 35	R9
NAU-167	Stalking crane hardwoods	M6
NAU-169	Stalking crane hardwoods	M6
NAU-172	26, 28, 29	M6, M9
NAU-105	22	C6
NAU-156	44, 47, 91	M9, M6
NAU-157	44, 43, 64, 68, 67	B6, M9, M6
NAU-198	2, 3, 5, 12, 28	M9, M6
NEW-79	38, 39	M6, M4
NEW-100	59, 60	M6

[1] Habitat types follow Michigan Department of Natural Resources Forest Operational Inventory (OI) designations and are defined as follows: M = northern hardwoods, E = lowland hardwoods, B = birch, A = aspen, W = white pine, P = balsam poplar, R = red pine, C = Cedar, F = spruce-fir J = jack pine, L = lowland brush, G = grass, O = oak, and Q = lowland conifers. Corresponding numerical values follow OI stocking density/size classes and are defined as follows: 0 = non-stocked, 1 = poorly stocked seedling/sapling, 2 = medium stocked seedling/sapling, 3 = well stocked seedling/sapling, 4 = poorly stocked pole timber, 5 = medium stocked pole timber, 6 = well stocked pole timber, 7 = poorly stocked saw timber, 8 = medium stocked saw timber, and 9 = well stocked saw timber.

APPENDIX III

MNFI Raptor Nest Reporting Form

RAPTOR NEST REPORTING FORM

Michigan Natural Features Inventory

Site Information
Observer(s) Name:_____ **Phone**:_____ **email**:_____
County:_____ **State Forest Area**:_____ **Compartment/stand**:_____
Date of Observation:_____ **Township/Range/Section:**_____
Directions to Site:_____
Survey and Biological Data
Weather (check): sunny ☐ mostly sunny ☐ partly cloudy ☐ mostly cloudy ☐ cloudy ☐
winds: 0-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ 20+ ☐ **Temperature:** ____
Precipitation: rain ☐ snow ☐
Circumstance of Observation:deliberate search ☐accidental observation ☐ responded to taped call ☐
Raptor Species Observed: red-shouldered hawk red-tailed hawk broadwing hawk northern goshawk Cooper's hawk northern harrier bald eagle osprey peregrine falcon merlin kestrel short-eared owl long-eared owl great horned owl other_____
Rank your identification: extremely confident confident some reservation not sure no clue
Describe individuals observed: # of adults_____# of juveniles_____
(check all that apply) birds heard calling ☐ birds observed but not calling ☐ birds observed & heard ☐
Nest Found (check all that apply): no☐ yes ☐; if yes nest decorated ☐ not decorated ☐ old nest ☐
presence of down ☐ evidence of new construction ☐ bird on nest ☐ birds heard in immediate vicinity of nest ☐
Nest tree species:_____ **Nest height:** 10-20' ☐ 21-30' ☐ 31-40' ☐ 41-50' ☐ 50'+ ☐
Nest tree DBH :_____**Age class**: Even ☐ Uneven ☐ **Presence of flight lane**: yes ☐ no ☐
Landscape Position: Slope ☐ Flat ☐ Upland ☐ Lowland ☐ **Canopy layers**: 1 ☐ 2 ☐ 3 ☐
Proximity to wetland (mi.): < 1/8 ☐ >1/8<1/4 ☐ >1/4<1/2 ☐ >1/2 ☐
Type of wetland habitat nearby: Conifer ☐ Hardwood ☐ Emergent ☐ Vernal Pool ☐ Shrub ☐
Other: _____

Understory density: Dense ☐ Moderate ☐ Sparse ☐ **Cover type**: M☐ A☐ B☐ O☐
Other_____
Stocking density: 5☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐

Productivity Surveys (if conducted)
Date:_____ **Observer(s):**_____ **Active**: Yes ☐, if yes young in nest ☐ whitewash at base of tree ☐ young of year in nearby trees ☐ No ☐ **Number of Young**: _____
Was there evidence of predation: no ☐ yes ☐If yes, nest torn apart ☐ claw marks on tree ☐ dead bird in or near nest ☐ other_____
Additional notes: _____
_____

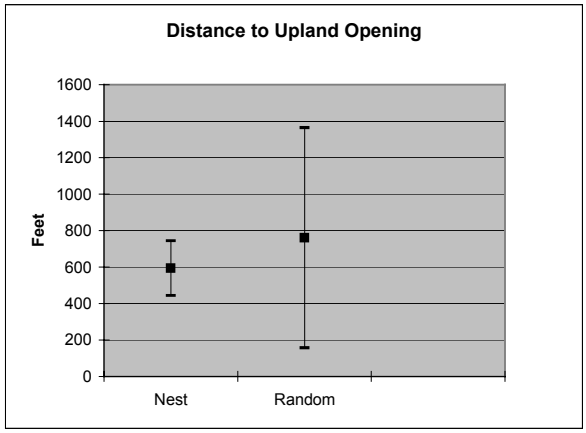
Please draw a map of nest site on back of form or attach compartment map or topographic map

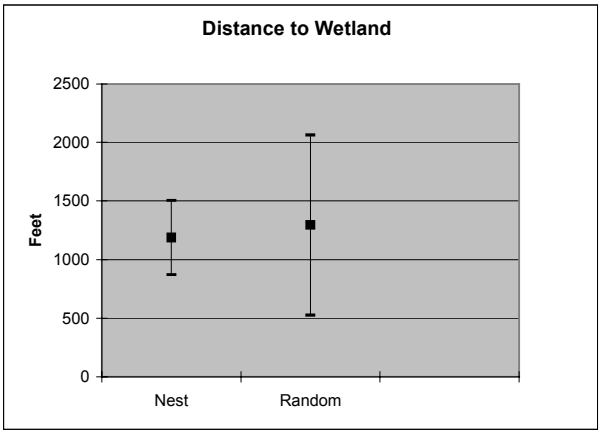
Send completed form to:
Dave Cuthrell, Michigan Natural Features Inventory, P.O. Box 30444, Lansing, Michigan 48909
For additional information: Dave Cuthrell, zoologist (517) 335-6627 Email: cuthreld@state.mi.us

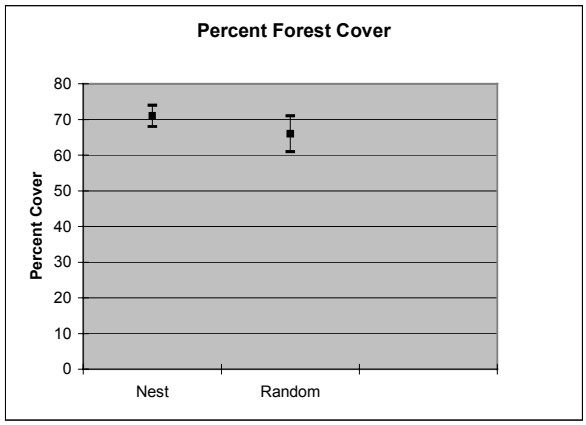
APPENDIX IV

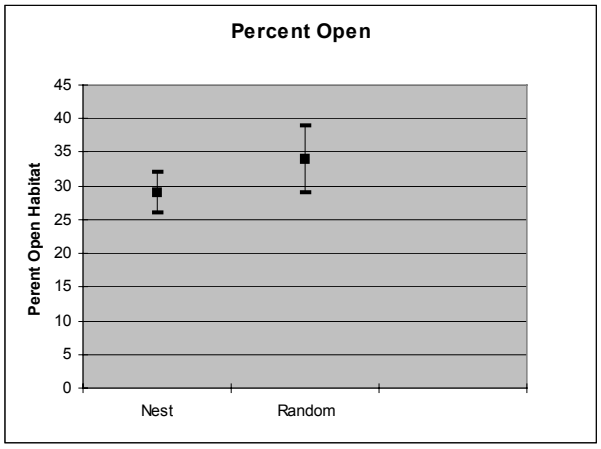
Means and Confidence Intervals (95%) for Landscape and Micro-habitat Variables for nest sites and random points

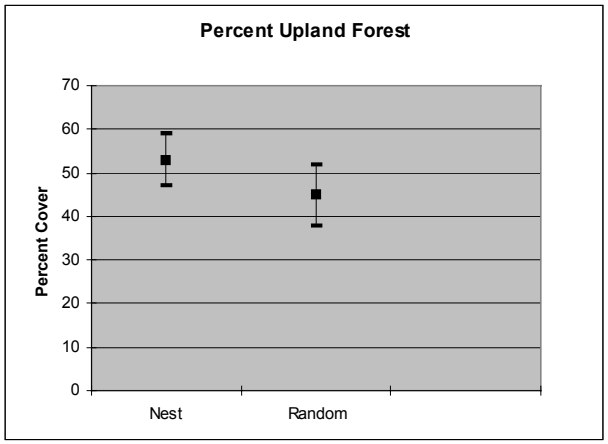
Landscape Attributes (n = 51 for nest sites and n = 48 for random points)

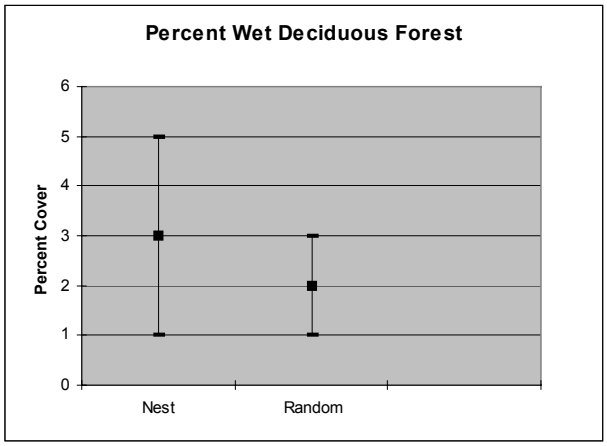


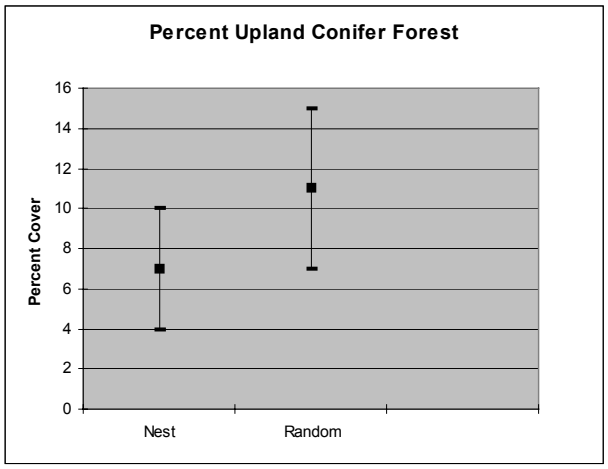


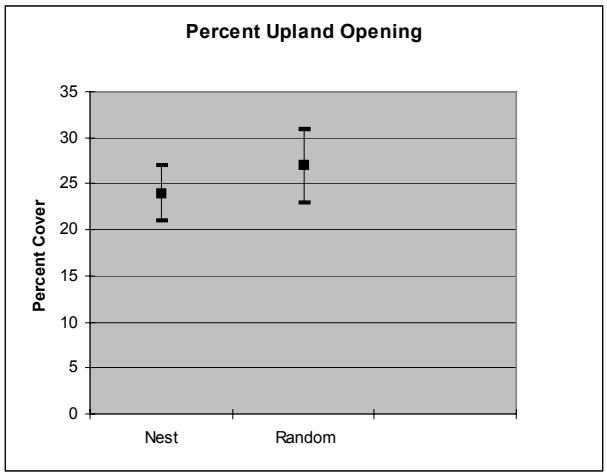


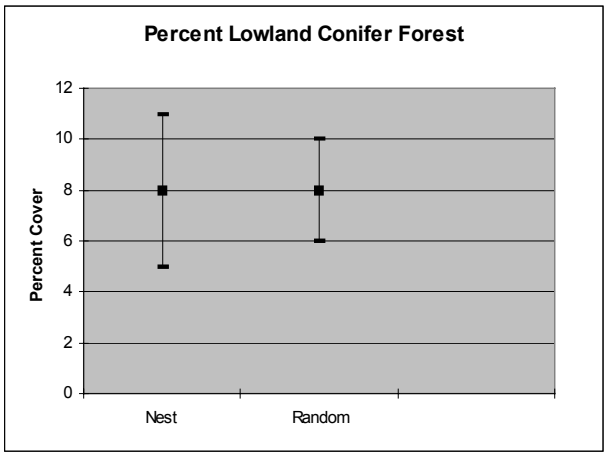


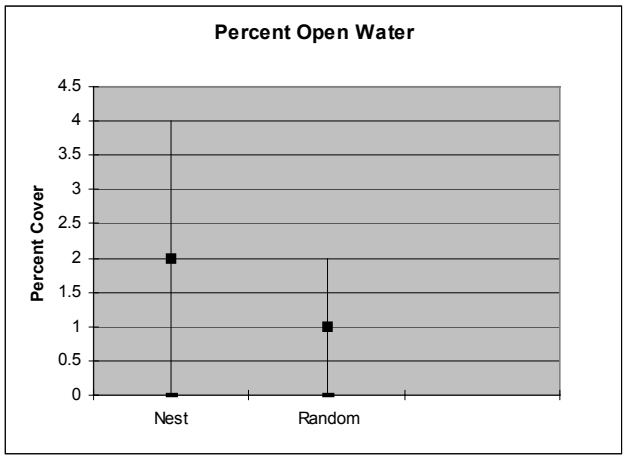


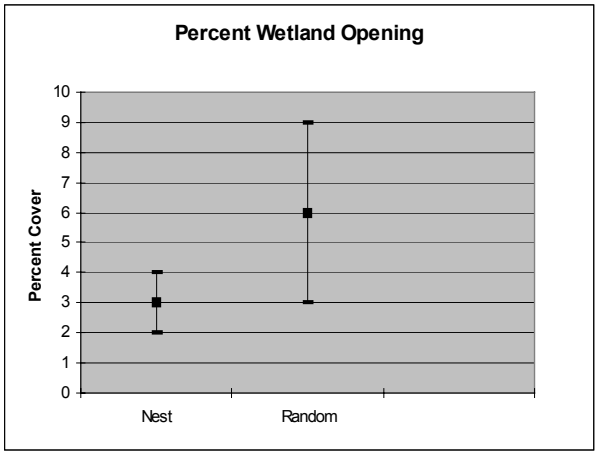



Percent Upland Conifer Forest
Percent Cover
16
14
12
10
8
6
4
2
0
Nest
Random

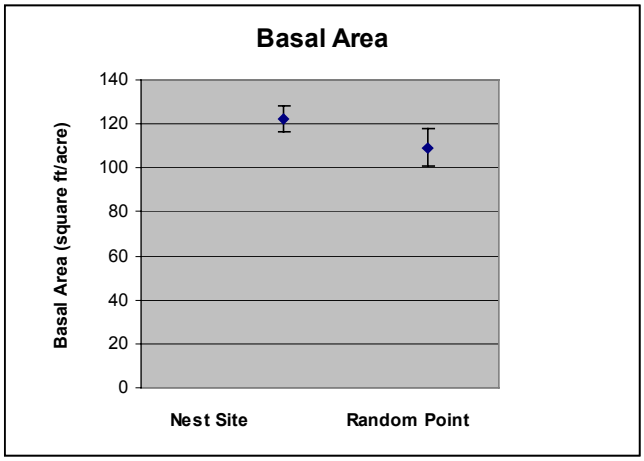

Percent Upland Opening
Percent Cover
35
30
25
20
15
10
5
0
Nest
Random

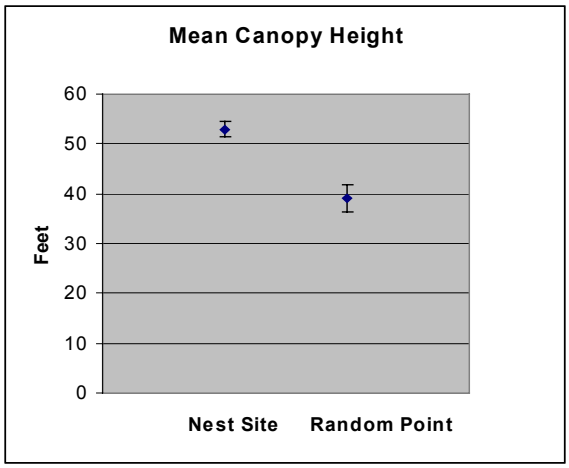

Percent Lowland Conifer Forest
Percent Cover
12
10
8
6
4
2
0
Nest
Random

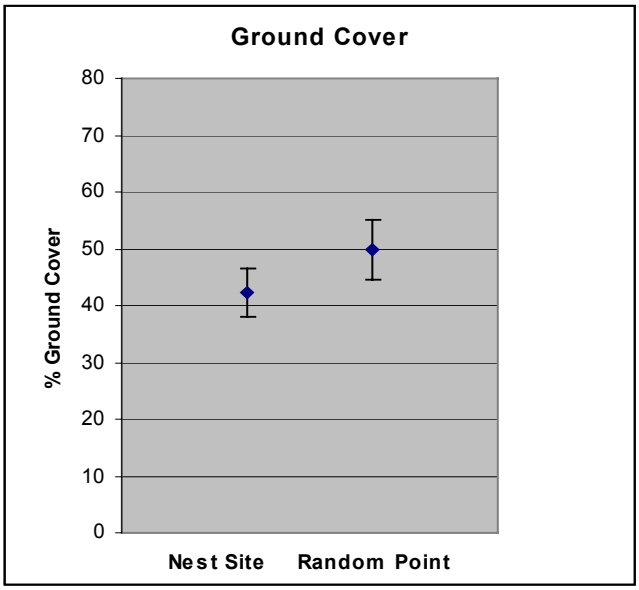

Percent Open Water
Percent Cover
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Nest
Random

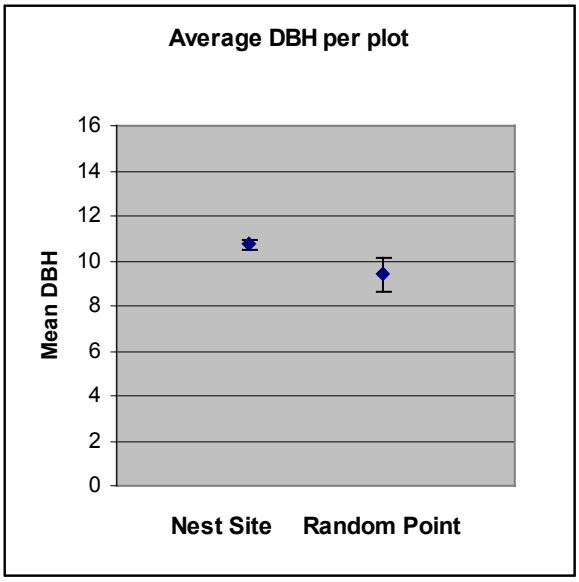

Percent Wetland Opening
Percent Cover
10
9
8
7
6
5
4
3
2
1
0
Nest
Random

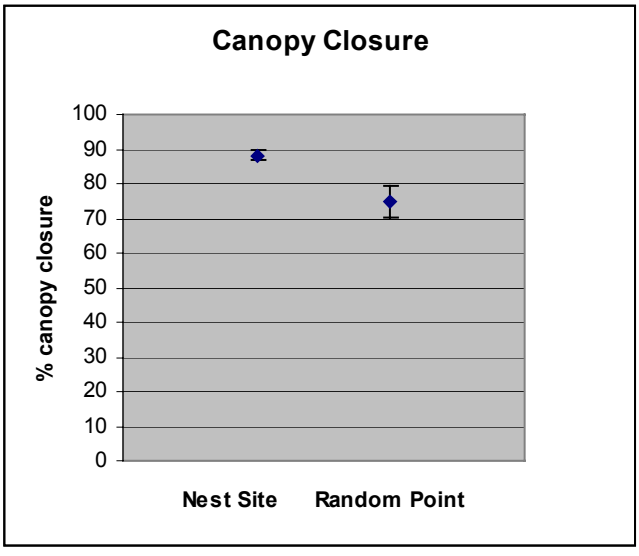
Micro-habitat Attributes (n=44 for nest sites and n=35 for random points)

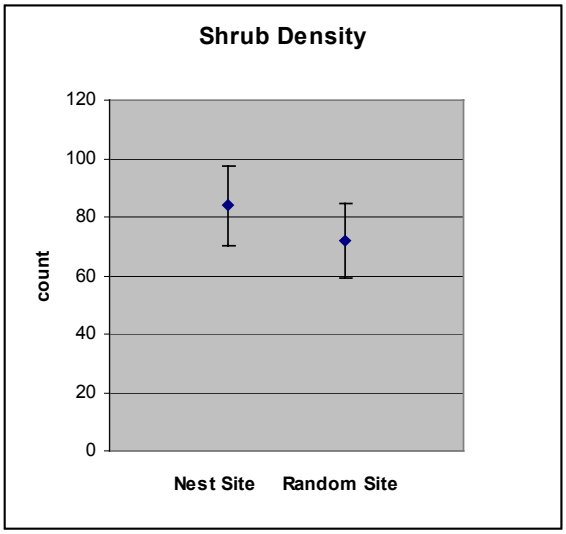


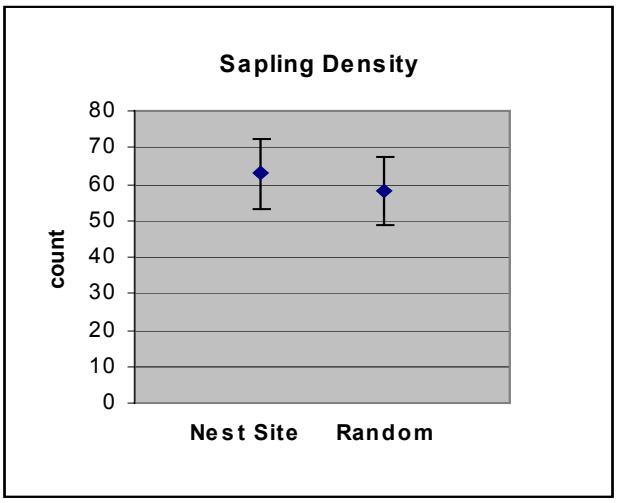


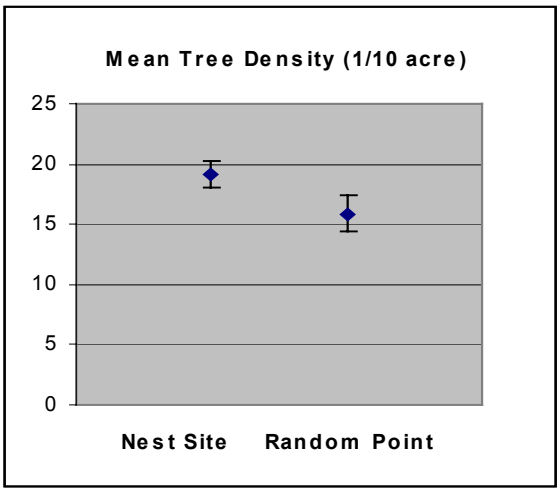









Sapling Density
count
80
70
60
50
40
30
20
10
0
Nest Site
Random


Mean Tree Density (1/10 acre)
25
20
15
10
5
0
Nest Site
Random Point

APPENDIX V

Locational data of red-shouldered hawk nests at seven Michigan state forest areas.

(Copies distributed to MDNR area managers only)

Sensitive data, do not distribute

Forest Area[1]	Nest Number	Location (TRS)	Compartment	Stand	Date first obs
PRC	PRC1	T33N, R1W, S.13 sw sw	PRC 12	84	04/22/1998
PRC	PRC2	T33, R1W, S.14 nw nw ne	PRC 11	52	04/20/1998
PRC	PRC3	T33N, R1W, S.30 ne ne	PRC 13	12	04/20/1997
PRC	PRC4	T33N, R1W, S.29 ne ne nw	PRC 14	31	04/21/1998
PRC	PRC5	T33N, R1W, S.32	PRC14	55	04/21/1998
PRC	PRC6	T33N, R1W, S.7 sw sw	PRC 7	53	04/22/1998
PRC	PRC7	T33N, R1W, S.18 se	PRC 7	61	04/23/1998
PRC	PRC8	T33N, R1W, S.4 se se	PRC 9	15	04/20/1998
PRC	PRC9	T33N, R1W, S.16 se	PRC 9	46	04/22/1998
PRC	PRC10	T33N, R1W, S.10 ne ne	PRC 10	26	04/21/1998
PRC	PRC11	T33N, R1W, S.3	PRC10	10	04/20/1998
PRC	PRC12	T33N, R1W, S.34 se se	PRC 16	52	04/20/1998
PRC	PRC13	T32N, R1W, S.1 nw sw	PRC 33	18	04/20/1998
PRC	PRC14	T32N, R1W, S.13 sw se	PRC 37	7	22-Apr
PRC	PRC15	T32N, R1W, S.11 sw sw	PRC 35	21	04/22/1998
PRC	PRC16	T32N,R1W, S.22 nw	PRC39	21	04/23/1998
PRC	PRC17	T32N, R1W, S.34 se se	PRC43	24	May-1998
PRC	PRC18	T34N, R1E, S.33 ne sw	PRC 20	69	04/23/1998
PRC	PRC19	T34N, R1E, S.1 ne ne ne	PRC 20	5	04/15/1998
PRC	PRC20	T33N R1W S.13 sw sw ne	PRC12	84	04/20/1999
PRC	PRC21	T33n R20W S.nw nw nw	PRC14	1	04/19/1999
PRC	PRC22	T33N R1W S.9 ne ne sw	PRC9	21	04/19/1999
PRC	PRC23	T33N R1W S. 34 ne ne	PRC16	47	04/20/1999
PRC	PRC24	T34N R1W S.34 S center	PRC4	DL MGT[2]	04/21/1999
PRC	PRC25	T33N R1W S.22se se ne	PRC16	16	04/21/1999
PRC	PRC26	T33N R1W S.28sw ne sw	PRC15	80	04/22/1999
PRC	PRC27	T33N R1E S.10 sw sw sw	PRC 24	92	04/22/1999
PRC	PRC28	T33N R1E S 7ne ne	PRC23	48	04/21/1999
PRC	PRC29	T32N R2W, S.19 sw sw se	Private land	NA	04/20/1999
PRC	PRC30	T33N R1E S.4 sw sw ne	PRC21	14	04/21/1999
PRC	PRC31	T31N R1W S.35&36	PRC52	56	04/20/1999
PRC	PRC32	T31N R1W S.10	PRC47	28	04/20/1999
PRC	PRC33	T31N R1W S.14 nw	PRC48	34	04/22/1999
PRC	PRC34	T31N R1W S.3	PRC 47	22	04/21/1999
PRC	PRC35	T34N R1E S. 6 ne	PRC 21	?	06/09/1999
PRC	PRC36	T33N R1W S.33 sw se	PRC15	73	04/08/1999
PRC	PRC37		Private land		06/08/1999
PRC	PRC38	T34N R1W S.34	Special Unit		06/08/2000
PRC	PRC39	T34N R1W S21 se se se	PRC39	?	04/13/1999
PRC	PRC40	T33N R1W S. 12 n 1/2	PRC35	29	04/12/2000
PRC	PRC41	T33N R1E S.31 sw sw	PRC29	47	04/12/2000
PRC	PRC42	T33N R1W S. 15 se1/2 se 1/4	PRC10	65	04/13/2000
PRC	PRC43	T33N R1W S. 28 ne sw	PRC15	60	05/28/2000
PRC	PRC44	T33N R1W S.24 ne sw	PRC18	6	04/13/2000
PRC	PRC45	T33N R1W S. 12 se se nw	PRC12	51	04/26/1999
PRC	PRC46	T33N R1W S.30 ne ne	PRC13	12	04/25/1999

Forest Area	Nest Number	Location (TRS)	Compartment	Stand	Date first obs
IR	IR1	T34N, R3W, S.9 nw	IR50	11	04/09/1998
IR	IR2	T33N, R3W, S.33	IR57	117	May-1998
IR	IR3	T36N, R5W, S.11 sw sw	IR16	26	04/15/1998
IR	IR4	T33N, R3W, S.27	IR58	44	04/24/1998
IR	IR5	T33N, R3W, S23	IR58	21	04/15/1998
IR	IR6	T34N, R1W, S.3 sw sw se	IR182	(2) 7	04/15/1998
IR	IR7	T34N, R1W, S.11 sw nw	IR183	104	04/15/1998
IR	IR8	T34N, R1E, S.9 ne ne se	IR111	36	04/15/1998
IR	IR9	T34N, R1E, S.17	PVT/IR111	near 23	04/15/1998
IR	IR10	T36N R6W S.10 nw	IR4	21	04/01/1999
IR	IR11	T37N R3W S.9 sw sw	IR139	4	04/09/1999
IR	IR12	T33N R2W S.36 ne ne	IR178	11	04/14/1999
IR(ATL)	IR13	T37N R1E S.36 se	IR100 (Atl174)	19	06/11/1999
IR	IR14	T36N R5W S.22ne sw	IR15	19	04/15/1999
IR	IR15	T37N R4W S.31se nw	IR22	26	04/14/1999
IR	IR16	T35N R2W S.14 nw nw nw	IR176	40	04/12/1999
IR	IR17	T39N R3W S.4 sw sw	IR 139	8	04/14/1999
IR	IR18	T37N R3W S.8 se se nw	Private land	NA	05/01/2000
IR	IR19	T37N R6W S.21 nw sw	IR1	2	06/08/2000
IR	IR20	T35N R2W S.12 se nw	IR177	51	07/12/2000
IR	IR21	T34N R4W S.25 nw ne	Private		04/16/2001
IR	IR22	T34N R4W S.27 se nw	27	29	04/??/1997
IR	IR23	T33N R3W S.14 se se	56	75	04/26/2001
IR	IR24	T34N R2W S.17 swswse	70	29	06/14/2001
Gaylord	GA1	T30N R6W S.5	GA54	18	04/29/1999
Gaylord	GA2	T32N R5W S.32 sw	GA44	19	04/29/1999
Gaylord	GA3	T33N R5W S.25 se ne ne	GA39	221	04/27/1999
Gaylord	GA4	T33N R5W, S. 26 sw sw ne	GA39	(47) 122	04/27/1999
Gaylord	GA5	T32N R4W S. 21 ne nw se	GA40	72	04/26/1999
Gaylord	GA6	T33N R4W S.4	GA43	17	04/29/1999
Gaylord	GA7	T33N R4W S.16 se	GA 35	19	04/27/1999
Gaylord	GA8	T31N R6W S.36 sw sw	GA50	37	04/29/1999
Gaylord	GA9	T30N R5W S.6	GA59	1	04/14/2000
Gaylord	GA10	T30N R6W S.9 nw sw	GA55	51	04/12/2000
Gaylord	GA11	T31N R6W S.17 sw se	GA51	52	04/09/2000
Gaylord	GA12	T32NR4W S.10 nw se	GA43	22	04/01/1999
Gaylord	GA13	T31N R5W S.17 se se	GA48	17	04/18/2001
Gaylord	GA14	T30N R6W S. 13 se nw	GA58	34	04/18/2001
Gaylord	GA15	T33N R5W S. 22 sw ne	GA39	17	04/18/2001
Gaylord	GA16	T33N R4W S. 34 ne ne se	GA42	25	04/18/2001
Gaylord	GA17	T30N R6W S. 16 se se se	GA55	26	04/17/2001
Gaylord	GA18	T29N R5W S. 6 ne nw ne	GA?	??	05/09/2001
Gaylord	GA19	T31N R6W S. 24 ne nw	GA50	8	05/16/2001
Trav. City	TC1	T24N R14W S.19 se se	TC34	60	04/08/1999
Trav. City	TC2	T24N R15W S. 26 sw nw	TC34	26	04/07/1999
Trav. City	TC3	T24N R15W S.23 ne se	TC34	24	04/28/1999
Trav. City	TC4	T24N R15W S.25 nw	TC34	28	04/28/1998
Trav. City	TC5	T24N R14WS.16 ne ne	PVT	NA	04/08/1999
Trav. City	TC6	T24N R15W S.25	TC34	33	04/18/2000

Trav. City	TC7	T24N R15W S.14	TC34	8	04/18/2000
Trav. City	TC8	T27NM R13W S.7	TC4	near 111	04/26/2000
Trav. City	TC9	T27N R14W S.13	TC4	73	04/18/2000
Trav. City	TC10	T27N R14W S.13	TC4	78	04/18/2000
Trav. City	TC11	T27N R14W S.32	Near TC7	17	04/17/2000
Trav. City	TC12	T27N R14W S.33	TC7	17	04/17/2000
Trav. City	TC13	T26N R13W S.31	TC16	63	04/26/2000
Trav. City	TC14	T26N R11W S.24	TC49	85, 86	04/26/2000
Trav. City	TC15	T26N R11W S.27	TC49	30	04/26/2000
Trav. City	TC16	T28N R7W S.15	TC30	42	05/15/2000
Trav. City	TC17	T24N R14W S.35	TC38	70	05/03/2001
Cadillac	CAD1	T24N R9W S.9	CAD126	71	04/20/2000
Cadillac	CAD2	T24N R7W S.11	CAD122	?	06/08/2000
Gladwin	GLAD1	T20N R5W S. 24 ne se	GLAD5	101	04/19/2001
Gladwin	GLAD2	T20N R3E S. 26 se se	Near 127	28	04/11/2001
Gladwin	GLAD3	T14N R2W S. 24	Near 115	65	04/24/1997
Gladwin	GLAD4	T14N R1W S. 3 ne ne	Near 113	38	04/24/1997
Newberry	NEW1	T45N R12W S. 11 nwnw	NEW100	59	05/02/2001
Naubinway	NAUB1	T43N R6W S. 23 se se se	NAUB105	22	05/01/2001
Naubinway	NAUB2	T44N R8W S. 21 se se	NAUB156	44	05/01/2001
Naubinway	NAUB3	T42N R11W S. 32 nw	NAUB198	12	04/30/2001

[1] PRC = Pigeon River Country Forest Management Unit, IR = Indian River Forest Area of the Gaylord Forest Management Unit, Gaylord = Gaylord South Management Unit, Trav. City = Traverse City Forest Management Unit, Cadillac = Cadillac Forest Management Unit.
[2] DL MGT = Dog Lake Special Management Unit.

APPENDIX VI

Special Animal Abstract for the Red-shouldered hawk

Buteo lineatus red-shouldered hawk

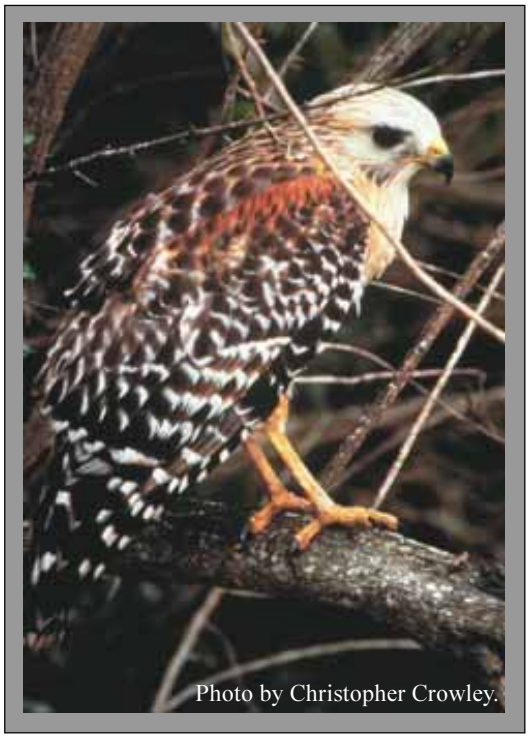
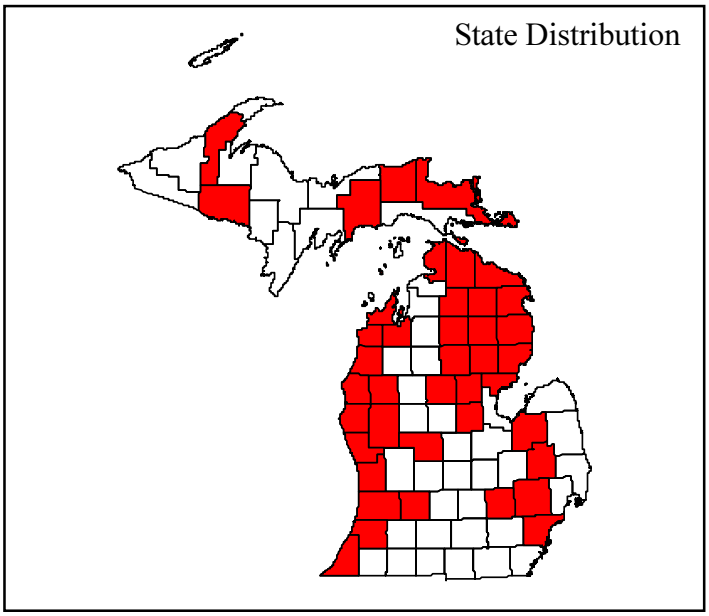
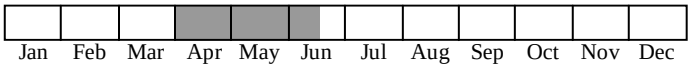


Photo by Christopher Crowley.



Best Survey Period



Status: State threatened

Global and State Rank: G5/S3S4

Family: Accipitridae (hawk family)

Total range: Breeding range for eastern populations is from Maine and southern Quebec west to Minnesota, and south to Florida, Texas, and central Mexico (Evers 1994). Wintering range for eastern populations is from Oklahoma, southern Wisconsin, southern Ohio and southern New England south to the Gulf Coast and Mexico (Johnsgard 1990).

State distribution: The distribution of breeding red-shouldered hawks has apparently shifted from their historical range in the southern Lower Peninsula to their present concentration in the northern Lower Peninsula. Breeding records are known from 42 Michigan counties. Currently, however, most breeding activity occurs mainly in two Lower Peninsula regions centering on Manistee County in the northwest and on the Straits area, from Cheboygan and Emmet counties to Alpena County (Ebbers 1991). High concentrations of nesting red-shouldered hawks with good reproductive success have been documented in the Manistee county area (Ebbers 1989). Also, recent survey work in Cheboygon, Emment, and Otsego counties (Pigeon River Country and Indian River forest areas) revealed numerous new nest locations that were highly successful over a two year period (Cooper et al. 1999). The Pigeon River Country and Indian River state forests areas and the Manistee County area provide good habitat for this species and these areas probably are important in terms of maintaining a viable population in Michigan.

Recognition: Adult red-shouldered hawks can be distinguished by the **reddish** coloration of their **underparts and wing linings** and their **five to six narrow, white tail bands**. In flight, they show **crescent-shaped translucent patches** lining the bases of the long, **outermost wing feathers** (the "primaries"). These patches are sometimes referred to as "windows". The bird's red shoulders are often not readily visible. Their **call** during the breeding season is distinctive, a **loud, rapidly repeated "kee-yer"**, though it is closely imitated by blue jays. Immatures have their underparts streaked with brown, teardrop-shaped spots. They may be readily identified by their underwing windows, as in the adults, and by their many narrow tail bands. Red-shouldered hawks can be distinguished from northern goshawks, Cooper's hawks, and sharp-shinned hawks by their shape, with a wider, more rounded tail and broader, longer wings than these other forest-dwelling hawks. The red-tailed hawk, a very common species, can be differentiated by the band of dark feathers running horizontally across its light belly, by the dark feathers lining the leading edge of its underwings, and by its reddish tail, which looks pinkish underneath in flight. The red-shouldered hawk can also be confused with the broad-winged hawk, but that species has three distinct black tail bands and creamy white wings outlined in black.

Best survey time/phenology: The red-shouldered hawk is migratory along the northern edge of its range and generally returns to Michigan in late February to early March, moving north with the retreating snow. Pairs arrive on

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their northern Lower Peninsula breeding grounds typically in mid-March (Ebbers 1991). Incubation of eggs occurs from late March to mid-April. Most young fledge in June (Craighead & Craighead 1956) and along with the adults remain near the nest site until migration in late fall.

Surveys are best accomplished from mid-April through early May, when birds are exhibiting territorial behavior, roads are relatively accessible, and leaves have not obscured nests. A standard and effective survey methodology for this species is to broadcast a red-shouldered hawk call with a tape recorder or predator caller in suitable habitat. Calling stations can be placed every 0.25 mile through suitable habitat. At each calling station a con-specific red-shouldered hawk call should be broadcast at 60 degrees for 10 seconds, 180 degrees for 10 seconds, and 300 degrees for 10 seconds. This calling sequence should be repeated three times (Kennedy and Stahlecker 1993). If a bird responds observers should look for a nest in the direction the call was initially heard.

Productivity surveys (i.e., nestling counts) can be conducted from early to mid-June. During this time period, young can often be viewed from the ground (Kochert 1986) or white wash (i.e., droppings from young) may be observed below the nest structure, which is evidence that young are or were recently present in a nest (Postupalsky, pers. comm.)

Habitat: In Michigan red-shouldered hawks utilize mature forested floodplain habitat, especially along the Manistee River. However, the majority of nests in Michigan have been found in large (usually >300 acres.), relatively mature deciduous or mixed forest complexes (medium to well stocked pole or saw timber stands). Typically these forest complexes have wetland habitats nearby or wetlands interspersed among these forested habitats (Cooper et al. 1999). Wetland areas such as beaver ponds, wet meadows and lowland forest are used primarily for foraging purposes (Howell and Chapman 1997). Upland openings are also used to some extent for foraging habitat (Evers 1994). Nests are typically placed in mature deciduous trees. American beech is the most commonly documented nest tree in Michigan and the presence of mature beech trees in forest stands may be an important factor that influences hawk utilization (Cooper et al. 1999, Ebbers 1989) However, a variety of nest trees have been utilized in Michigan (e.g., aspen, birch, ash, oak, etc.) which seems to indicate that tree structure and not the type of tree species is the most important factor that influences use of a tree for nest placement (Cooper et al. 1999). Nests are typically placed 35-40 feet above the ground but below the canopy, in a crotch 1/2 to 2/3 of the way up the tree (Ebbers 1989; Johnsgard 1990, Bednarz and Dinsmore 1981, Cooper et al. 1999). Also, nest sites tend to be housed in dense stands of timber with a closed canopy structure and very near wetland habitat (typically within 1/8 mile) (Johnsgard 1990, Cooper et al. 1999).

Biology: The red-shouldered hawk is a highly territorial breeder, and territories and nest sites are often reused for many years (Craighead & Craighead 1956, Bent 1937). In a recent two-year study in Michigan, territorial re-occupancy was high (78% of breeding territories were re-occupied between years) and nest re-occupancy between years was reported at a high rate as well (50% of the same nests were re-used between years) (Cooper et al. 1999). This species is very vocal in territorial defense as well as during its high-flying nuptial displays. The large, bulky nests are built of twigs and are usually "decorated" with greenery and other materials. Two to four eggs are typically laid. Eggs are incubated for about one month primarily by the female, while the male supplies food to her, and later also to the chicks. Great-horned owls and raccoons are common nest predators. The young fledge at about six weeks of age and begin to breed typically at two years old. Prey includes small rodents and birds, snakes, frogs, crayfish, and larger insects, with the proportion taken varying in different locations and possibly over time (Palmer 1988). The bird hunts below the forest canopy and in open, nearby wetlands by perching and waiting for prey. They may also glide low to the ground and surprise prey up close (Palmer 1988).

Conservation/management: The primary threat to this species in Michigan is habitat alteration and destruction due to timber harvest, road construction, and residential development (Evers 1994). Habitat manipulation directly impacts the species by alteration of suitable structure around the nest site and indirectly by influencing the abundance, distribution, and vulnerability of prey species. Fragmentation of forest stands and the creation of larger openings favor the immigration of nest competitors and predators such as the red-tailed hawk (*Buteo jamaicensis*) and great-horned owl (*Bubo virginianus*) (Bryant 1986). These species can either displace a nesting pair or directly depredate young and/or adults from a nest site. Management practices that maintain greater than 70% canopy closure, retain large trees for nesting, and conserve large contiguous blocks of deciduous or mixed forest stands and associated wetland habitat should benefit this species. Currently management has focused on maintaining the critical components of individual home ranges such as the nest area, post fledgling area, and foraging area. However, a more proactive and ecologically sound practice, to ensure conservation of the species on a long term scale, would be to manage large tracts of forest as ecological units. Ecological units should be analyzed and managed across vegetation types and land ownership pattern in order to maintain the array of ecological processes needed for this species (Graham et al. 1994).

Research needs: There are many research needs concerning this species some of which are listed below. More systematic survey of Michigan is needed in order to gain a better sense of breeding pair density and habitat use, especially in the Upper Peninsula. Further, once breeding territories are located productivity (i.e., the percentage of nests that produced at least 1 young to the fledgling stage)

needs to be monitored in order to assess where viable populations occur. Also, little research has been conducted on the impacts of silvicultural practices on habitat use and nest productivity. Other research needs include but are not limited to home range size, movement patterns, analysis of landscape-level habitat patterns, impacts of predation, and investigation of post-fledgling habitat.

Related abstracts: northern hardwood forest, northern goshawk, woodland vole

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Abstract citation

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