Red-shouldered Hawk Inventories and Assessment of Nest Productivity at the Pigeon River and Indian River Forest Areas

Michigan Natural Features Inventory
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Introduction

The red-shouldered hawk (*Buteo lineatus*) is 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 ~180 confirmed nests documented since the early 1980's (Michigan Natural Features Inventory 1999). 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 on the Manistee County area. Only scattered occurrences of confirmed red-shouldered hawk nests occur in the SLP and the Upper Peninsula.

This species is a woodland raptor that requires large tracts of deciduous or mixed forests. The prototypical 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). In Michigan this species has been most frequently documented in northern 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(A6/9), lowland poplar stands (P6), and occasionally in pine communities (W8/9) (Michigan Natural Features Inventory, unpublished data). 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 1997). Red-shouldered hawks typically nest in stands of timber with greater than 70% canopy closure (Bryant 1986) and relatively open understories (Evers 1997). 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). Mature maple, beech, birch, and aspen are frequently used nest trees in Michigan (Ebbers 1986). 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, especially on 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 continue over the next four years, 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). 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 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 2 years of a 6 year study and includes an assessment of territorial re-occupancy, nest site re-occupancy, and nest productivity. Further, habitat data at the landscape and micro habitat scales from confirmed nest sites and random points are in the process of being quantified, summarized, and statistically analyzed (to be included in a later report).

Methods

Establishment of Calling Stations

Surveys were conducted from early April – mid-May of 1998 and 1999. High priority forest compartments at the Pigeon River Country (PRC) Forest Management Unit, and the Indian River (IR) area of the Gaylord Forest Management Unit were intensively surveyed for red-shouldered hawks. 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 (see appendix III 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, and by consulting with Michigan Department of Natural Resources (MDNR) Forest Management Division (FMD) and Wildlife Division 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 3 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 3 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 3 random calling stations were established per compartment surveyed and the same calling sequence mentioned above was utilized (Moritz, pers. comm.). Random calling stations were added to surveys during 1999 for future statistical comparisons in order to differentiate habitat patterns around nest sites from habitat patterns that occur throughout the larger landscape. Red-shouldered hawk survey forms (Appendix II) were filled out at each survey site and confirmed nest locations were transcribed and entered into the Michigan Natural Features Inventory's Biological Conservation Database.

Productivity Surveys

During early June of 1998 and 1999, a representative subset of nests were re-visited 1 time 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 utilized 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, and looking into the nest with a mirror attached to a long pole. A nest was considered successful if at least 1 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, and 1978 current land cover maps. The percentage of nests occurring in the following categories was calculated: cover type (OI designations), location in upland or lowland, proximity to wetland, and stocking density/size class (OI designations). The percent cover of habitat types around nest sites documented during 1998 (n=26) was calculated by centering the nest site within a 1.8 km x 1.8 km (1 mi x1mi) quadrat (Ebbers 1986, Bowerman pers. comm.). The percent cover of each habitat type was estimated within the quadrat. Each respective cover type was delineated by utilizing OI maps and changes that recently occurred in habitat composition were corrected with 1998 air photos.

Nest site Variables

Various nest site variables were summarized including: nest tree species, estimated nest height, timber age class (i.e., even/uneven), nest tree DBH, understory density, and basal area.

Results/Discussion

Compartments Surveyed

A total of 35 PRC and 25 IR compartments were systematically surveyed during 1998 and 1999 (Appendix III). Virtually all high quality habitats (i.e., large deciduous or mixed, pole/saw timber complexes juxtaposed or interspersed with wetland habitat) were surveyed. 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 (see Appendix III) as well as varying landscape positions (e.g., upland/lowland) were systematically surveyed.

Territory Activity

A total of 38 active territories (i.e., area where hawks were heard or had a freshly tended nest) were documented between forest areas during 1998 (Table 1). Total number of active territories was 21 at the PRC. Among theses active territories, 19 active nests (i.e., where incubation was confirmed) were located. At the IR forest area, 17 active territories with 9 active nests were documented. During 1999, 49 active territories were documented at the PRC and 30 at the IR. At the same time, 18 new nest locations were found at the PRC and 8 new locations at the IR forest area. A total of 54 active nests were found between the years of 1998 and 1999 (Table 1).

Territorial re-occupancy was high for both forest areas (Table 1). At the PRC, 74% of the breeding territories (n=19) re-visited during 1999 had either an active nest or territorial bird present. At the IR forest area, 88% of the territories (n=8) re-surveyed were re-occupied by red-shouldered hawks. When data were pooled from both forest areas, territorial re-occupancy was 78% (n=27). 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 1999 at the PRC and IR 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 at the PRC and IR (Table 1). Fifty percent of the nests utilized in each forest area (PRC, n=18; IR, n=8)

during 1998 were re-occupied during 1999. Johnsgard (1990) felt that a nest re-occupancy rate of 37%, which was documented by Jacobs et al. (1988) in Wisconsin, was high. Nest site fidelity in both forest areas exceeded this rate in 1999.

Table 1. Breeding territory activity at the Pigeon River Country (PRC) and Indian River (IR) forest areas.

Reproductive Variable	PRC	IR	Overall
Number of Territories[1]	1998 - 21 1999 - 49	1998 - 17 1999 - 30	1998 - 38 1999 - 79
Number of Territories Reoccupied [2]	14 out of 19 (74%)	7 out of 8 (88%)	21 out of 27 (78%)
Number of New Nests Documented [3]	1998 - 19 1999 - 18	1998 - 9 1999 - 8	**2-year total - 54**
Nest Site Fidelity [4]	9 out of 18 (50%)	4 out of 8 (50%)	13 out of 26 (50%)

[1] Areas where red-shouldered hawks were observed, heard, or had a freshly tended nest during the breeding season.
[2] The percentage of territories documented during 1998 that were re-utilized during 1999.
[3] The number of newly discovered active hawk nests.
[4] The percentage of nests occupied during 1998 that were re-utilized during 1999.

At the PRC, known active nest sites were distributed rather evenly throughout large contiguous hardwood/wetland complexes. 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 2.1km 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 at the PRC during 1998 and 1999 surveys, which may suggest that large areas of the PRC Forest Management Unit offer suitable nesting habitat for the RSH, provided sufficient prey base is available in a given year. Uniform nest spacing at the IR forest area was not as apparent. This is most likely due 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 1998 and 1999 were re-visited during June, 1998 and June, 1999 (Table 2). During 1998 at the PRC, 62% of nests (n=13) revisited during the nestling period were successful (i.e., produced at least 1 young 80% of fledging age). Nest predation was confirmed (e.g., claw marks on trees, den tree nearby, nests torn apart, etc.) at 23% of the nest sites. The fate of the remainder of the nests (15%) is unknown. During 1999 at the PRC Forest Management Unit, 76% of the nests were successful, 14% depredated, and 10% were either abandoned or depredated. At the IR forest area, during 1998, productivity surveys were conducted at 7 sites. Seventy-one percent of these nests were successful, one nest (14%) was depredated, and one nest (14%) was either depredated or abandoned. During 1999, all IR nests (n=9) re-visited were successful. The overall nest success rate (i.e., data from both forest areas pooled together) for 1998 was 65% and for 1999 nest success was 83%, for a 2-year average nest success rate of 76%. The primary nest

predator implicated was the raccoon (*Procyon lotor*). Jacobs and Jacobs (1997) and Ebbers (1989) also documented the raccoon as a primary predator of red-shouldered hawks in Wisconsin and Michigan, respectively. In addition, a few instances of nest predation were tied to black bear (*Ursus americana*).

Average brood size (number of young per successful nest), from nest site data combined for both forest areas, was 2.3 young per successful nest (n=10). Brood counts were not conducted at all sites because nests were too high to view with a mirror pole and/or an adequate vantage point was not available to determine the number of individual young in a nest. Therefore, due to a small sample size, the average brood size documented during this study may not accurately reflect typical brood sizes for all successful nests.

Table 2. Productivity of red-shouldered hawk nests at the Pigeon River Country (PRC) and Indian River (IR) forest areas.

Reproductive Variable	PRC	IR	Overall
Percentage of Successful Nests [1]	1998 - 8 out of 13 (62%) 1999 - 16 out of 21 (76%)	1998- 5 out of 7 (71%) 1999 - 9 out of 9 (100%)	1998 - 13 out of 20 (65%) 1999 - 25 out of 30 (83%) **2-year total - 76%**
Number of Young per Successful Nest [2]	1999 - 2.3 (n=7)	1999 - 2.3 (n=3)	2.3 (n=10)
Nest Predation Rates [3]	1998 - 3 out of 13 (23%) 1999 - 3 out of 21(14%)	1998 – 1 out of 7 (14%) 1999 – 0 out of 9 (0%)	1998 - 4 out of 20 (20%) 1999 - 3 out of 30 (10%) **2-year average -14%**

[1] The percentage of nests with $\geq$ 1 young produced to 80% of the fledgling age (4 – 4.5 weeks old)
[2] The number of nestlings 80% of the fledgling age/successful nest
[3] The percentage of nests that were destroyed by a nest predator

Nest success rates were good over the past two years and compare rather favorably with other studies concerning this species (Table 3). However, wide variations in nesting success rates can occur (Jacobs and Jacobs 1997, Stavers et al. 1995, and Henny et al. 1973). Monitoring of nest success rates at both forest areas only spans a two year period and varied markedly between years. Therefore, in order to fully assess population viability at the PRC and IR forest areas, monitoring will need to continue over the next several years. Monitoring of nest sites is tentatively planned until 2003. Further, sample sizes for the number young fledged per successful nest was low (n=10) due to methodological problems which did not allow counting brood sizes at all successful nests. Jacobs and Jacobs (1997) felt that the number of young fledged per successful nest was the most important reproductive parameter utilized in assessing population viability. Therefore, greater effort will be made to correct methodological problems in order to increase future sample sizes.

The factors that resulted in high nest success rates at the PRC and IR are not known. However, Jacobs and Jacobs (1997) and Newton (1979) felt that weather and prey availability 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 eat and more food to feed their broods, which likely results in 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 two years that surveys were conducted on state forest lands, winters were mild and spring weather began earlier than normal. Therefore, mild weather conditions 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. Continued monitoring of productivity over a period of several years within each forest area should reveal factors that limit or enhance nest productivity.

Table 3. Comparison of red-shouldered hawk nest success rate for the Pigeon River Country and Indian River forest areas with eight other studies.

Location	No. Nests Studied	% of Nests Successful	No. Young Fledged / Successful Nest	Source
California	29	66	1.3	Wiley 1975
Central and ne. Wisconsin 1990-97	449	50	1.1	Jacobs and Jacobs 1997
Central Maryland	74	68	1.6	Henny et al. 1973
Central Ontario	6	83	1.8	Armstrong and Euler 1982
Iowa	8	88	2.9	Bednarz 1979
Missouri	9	100	2.6	Kimmel and Fredrickson 1981
Northern Michigan 1986-1988	44	57	1.2	Ebbers 1989
Northern Michigan 1998-1999	**50**	**78**	**2.3**	**This report**
Western Maryland	17	53	1.8	Janik and Mosher 1982

Habitat Structure

Landscape Scale

Analysis of landscape-level attributes revealed some interesting habitat patterns around nest sites. During 1998, the area around twenty-six nest sites were analyzed for landscape composition (Table 4). The majority of the landscape surrounding nest sites was composed of a northern hardwood community type (67%). Wetland/aquatic habitats encompassed nearly 13% of the landscape. Overall, 77% of the landscape was forested and 23% open habitat. Open habitat was composed mainly of upland opening (e.g., grass opening, seedling stands, etc.). The percentage of cover types around nest sites documented during this study compared fairly well with a similar study conducted by Ebbers (1989) in the NLP (Table 4).

Table 4. A comparison of cover types at red-shouldered nest sites in the Straits region of Northern Michigan

Variable	MNFI 1998 (n = 26)	Ebber's 1989 (n = 18)
% Upland Forest	67.00	51.00
% Swamp Forest	10.00	22.00
% Upland Opening	20.00	20.00
% Surface Water	0.23	5.00
% Wetland Opening	2.50	2.00

A wide range of cover types of varying stocking densities were intensively surveyed for red-shouldered hawks (Appendix III). Further, 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 strong deciduous tree component could provide good nesting habitat for red-shouldered hawks and these habitats will be more intensively surveyed in the future.

The vast majority of nest sites were located in northern hardwood stands (Table 5). Stands of oak, aspen, and white pine contained smaller percentages of nest sites (Table 5). Nests located were typically placed in upland habitat (82%) but very near wetlands (84% less than an 1/8 mi from a wetland habitat). Nests tended to be placed in tracts of timber that were composed of well stocked pole or saw timber, which typically have a closed canopy structure.

Throughout the species' range, red-shouldered hawks are generally associated with floodplain forests (Evers 1997). 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. At the PRC and IR forest areas extensive tracts of floodplain forest are lacking. However, landscapes in these forest areas are composed of a matrix of upland forests and a variety of wetland habitats. Red-shouldered hawks in these forest areas appear to heavily utilize the interface between upland hardwoods and wetland habitats. Most nests are found in upland hardwood systems but very near wetland complexes, which are most likely used for foraging. Howell and Chapman (1997) also found that red-shouldered hawks heavily exploit the ecotone between uplands and wetlands in Georgia.

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

Landscape Variable	Pigeon River Country (n=37)	Indian River (n=17)	Overall (n=54)
Cover Type[1]	Northern Hardwoods - 84% Oak - 8% Aspen - 3% White Pine - 5%	Northern Hardwoods - 76% Aspen - 12% Birch - 12%	Northern Hardwoods - 81% Oak - 5.5% Aspen - 5.5% White Pine - 4% Birch - 4%
Stocking Density/Size Class[2]	5 = 3% 6 = 59% 8 = 8% 9 = 30%	6 = 65% 9 = 35%	5 = 2% 6 = 61% 8 = 6% 9 = 31%
Location of Nest (upland or lowland)	95% Upland 5% Lowland	82% Upland 18% Lowland	91% Upland 9% Lowland
Proximity to Wetland	<1/8 mi = 88% ≥1/8 mi - <1/4 mi = 12%	<1/8 mi = 75% ≥1/4 mi - <1/2 mi = 6% >1/2 mi = 19%	<1/8 mi = 84% ≥1/8 mi - <1/4 mi = 8% ≥1/4 mi - <1/2 mi = 2% >1/2 mi = 6%

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

Nest Site Variables

The majority of nests were placed in mature beech trees (43%); 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 (Ebbers 1989). However, the diversity of nest trees utilized in Michigan seems to indicate that tree structure and not the type species is the most important factor that influences use of a tree for nest placement. Nests were typically placed high 12 m ± 0.88 m (41 ft ± 3 ft) and within a multi-pronged crotch of the nest tree, which concurs with results obtained by Titus and Mosher (1981). Stands of timber that housed nest sites were rather dense (basal area = 30 m^2 ± 2.1 m^2, 99 ft^2 ± 7 ft^2) and had a closed canopy structure. Johnsgard (1990) noted that red-shouldered hawk nests tended to be placed in dense, relatively mature stands of timber with closed canopies, and near wetland habitats. Habitat patterns around nest sites in the PRC and IR exhibit similar structural attributes reported by Johnsgard (1990).

Table 6. Nest tree species utilized by red-shouldered hawk at the Pigeon River Country and Indian River forest areas.

Tree Species	Pigeon River (n=37)	Indian River (n=17)	Overall (n=54)
American Beech (*Fagus grandifolia*)	43%	41%	43%
White birch (*Betula papyrifera*)	11%	23%	15%
Sugar Maple (*Acer saccharum*)	14%	12%	13%
Basswood (*Tilia americana*)	13%	6%	11%
Red Oak (*Quercus rubra*)	8%	0%	6%
Aspen (*Populus* spp.)	5%	12%	6%
Yellow birch (*Betula lutea*)	3%	0%	2%
White ash (*Fraxinus americana*)	0%	6%	2%
White pine (*Pinus strobus*)	3%	0%	2%

Table 7. Red-shouldered hawk nest site characteristics at the Pigeon River Country and Indian River forest areas.

Nest Site Variable	Pigeon River	Indian River	Overall
Age Class	64% even-aged 36% uneven-aged n=36	53% even-aged 47% uneven-aged n=17	58% even-aged 42% uneven-aged n=53
Basal Area[1]	30 m^2 $\pm$ 2.7 m^2 (99 ft^2 $\pm$ 9 ft^2) n=18	29 m^2 $\pm$ 3.6 m^2 (97 ft^2 $\pm$ 12 ft^2) n=8	30 m^2 $\pm$ 2.1 m^2 (99 ft^2 $\pm$ 7 ft^2) n=26
DBH	43 cm $\pm$ 2.54 cm (17 in $\pm$ 1 in) n=35	43 cm $\pm$ 5 cm (17 in $\pm$ 2 in) n=17	43 cm $\pm$ 2.54 cm (17 in $\pm$ 1 in) n=52
Nest Height	13 m $\pm$ 0.9 m (43 ft $\pm$ 2.8 ft) n=37	11 m $\pm$ 2.0 m (38 ft $\pm$ 7 ft) n=17	12 m $\pm$ 0.88 m (41 ft $\pm$ 3 ft) n=54

[1] Basal area data from 1998 nest sites.

Conclusions

Hawk surveys at the PRC and IR 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 is needed to fully assess population viablity. The results from inventories and nest monitoring, at the PRC and IR, as well as future work in other Northern Lower and Upper Peninsula forest areas, should provide very valuable

information. This information could 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 four years at least 20 representative nest sites 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. Habitat parameters (landscape and micro-habitat scales) are in the process of being quantified and summarized for all nest locations documented to date. Random point data was collected in all compartments surveyed and these habitat parameters (landscape and micro-habitat scales) are also in the process of being quantified and summarized. Nest site data and random point data will be statistically compared to differentiate habitat patterns around nest sites from habitats patterns that occur throughout the larger landscape. 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.

Work Plan

Year 1

- Finish systematic surveys of 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 Management Unit
- Monitor 20 nests, or as many as available if less than 20 nests sites, in each forest area

Year 2

- Check monitored nest territories in Pigeon River, Indian River, and S. Gaylord Management Unit to locate active nests
- Systematically survey the Traverse City Forest Areas and select areas in the UP
- Monitor 20 nests, or as many as available if less than 20 nest sites, in each forest area

Year 3

- Check monitored nest territories in Pigeon River, Indian River, S. Gaylord, Traverse City, and the UP to locate active nests
- Systematically survey the Gladwin Forest Area and select areas of the UP
- Monitor 20 nests, or as many as available if less than 20 nest sites, in each forest area

Year 4

- Check monitored nest sites in Pigeon River, Indian River, S. Gaylord, Traverse City, Gladwin, and the UP
- Systematically survey the Atlanta Forest Area and select areas in the UP
- Monitor 20 nests, or as many as available if less than 20 nest sites, in each forest area

Year 5

- Check monitored nest sites in Pigeon River, Indian River, S. Gaylord. Traverse City, Gladwin, Atlanta, and the UP
- Finish systematic surveys in the UP
- Monitor 20 nests, or as many as available if less than 20 nest sites, in each forest area

APPENDIX II

Red-shouldered hawk survey form

For Office Use Only

Ouad Code:_____
Air Photo:_____
Basal Area:_____

Michigan Natural Features Inventory
RED-SHOULDERED HAWK SURVEY FORM

Systematic Surveys For Nest Locations

Date: _____ **Observer**(s):_____
Location (TRS ¼ S) :_____ **County(s)** :_____
Directions to nest site :_____
_____
_____
_____
Forest compartment/stand :_____ **Nest tree species** :_____
Nest height :_____ **Nest tree DBH** :_____ **Age class** : Even/Uneven
Landscape Position : Slope/Flat Upland/Lowland **Canopy layers**: 1 2 3
Proximity to wetland :_____
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
Notes: _____
_____
_____
_____
_____

Productivity Surveys

Date:_____ **Observer(s)** :_____

Active: Yes No **Number of Young** : _____

If inactive was there evidence of predation: Yes No

Notes: _____
_____
_____
_____
_____
_____
_____
_____

Please draw a map of nest site on back of form

Michigan DNR

APPENDIX III

Forest Compartments and stands surveyed for red-shouldered hawks at the Pigeon River and Indian River forest areas.

The following table show compartments and stands surveyed and habitat types targeted for surveys at the Pigeon River and Indian River forest areas

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

Compartment Surveyed	Stands Surveyed	Habitat(s) Surveyed [1]
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
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

[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 IV

Locational data of red-shouldered hawk nests at the Pigeon River and Indian River forest areas.

(Copies distributed to MDNR area managers only)