Conservation Assessment

for

Red-shouldered Hawk (Buteo lineatus)

USDA Forest Service Eastern Region
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This Conservation Assessment was prepared to compile the published and unpublished information on Red-shouldered Hawks. It does not represent a management decision by the U.S. Forest Service. A Conservation Approach will be developed later and conservation measures incorporated into Forest Plans; public involvement will occur via the NEPA process. Although the best scientific information available was used and subject experts were consulted in the preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving this species, please contact the Eastern Region of the Forest Service Threatened and Endangered Species Program at 310

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Photographs Photographs by the authors

EXECUTIVE SUMMARY

The Red-shouldered Hawk is a medium sized woodland hawk that is widespread in eastern United States, southeastern Canada, southwestern Oregon, California and northern Mexico. Prior to 1900, it

was one of the most common hawks in eastern United States, including the north central states. It was not reported as a breeder for Minnesota until 1935.

Red-shouldered Hawk populations now appear to be very low, but stable and scattered throughout the north central states, with a few local areas where they are relatively common. Although pesticides might have affected some local populations, loss of prime nesting habitat appears to have caused their population decline. Availability of nest site habitat appears to pose the greatest limiting factor for these birds. State status of Red-shouldered Hawks varies from endangered, threatened, rare or of special concern for most north central states. It is listed by the US Fish and Wildlife Service, Region 3, Fish and Wildlife Resource Conservation Priorities as a rare/declining species (1999). Breeding Bird Atlases collectively reported only 12% of the survey blocks in the north central states had Red-shouldered Hawks, while the more common Red-tailed Hawk (*Buteo jamaicensis*) was reported for 76%. Breeding Bird Atlases also show that national forests and other publicly owned forest lands are a refugium for Red-shouldered Hawks. These birds are recovering or stable in other parts of their range where suitable habitat remains or has regrown. Red-shouldered Hawk populations in parts of the north central states appear to have begun recovery also.

Red-shouldered Hawks nest in contiguous, mature, closed canopy, wet hardwood forests. The slope of the land can be flat or hilly. Most of this habitat had been altered by 1900. Breeding ranges average 90-175 ha (225-438 acres). Approximately 66% of the breeding ranges are reoccupied the following year. Some sites have been reoccupied for over 25 consecutive seasons. A typical nest is built approximately 17 m (56 ft) above the ground in a very large hardwood. Three to four eggs are laid in March or April. The young fledge in May or June. Most Red-shouldered Hawks that nest in Minnesota, Wisconsin and Michigan are migratory. Adult birds migrate south from October to December and return north to their nesting areas by March or April. Red-shouldered Hawks that nest in southern Missouri, Illinois, Ohio, and Indiana appear to remain on or near their nesting grounds year round.

Primary prey items are small mammals, reptiles and amphibians with an occasional small bird, fish, crayfish or large insect taken. Most young return to breed within 50 km (30 mi.) of their natal nest and disperse in a northerly direction. Red-shouldered Hawks can live up to 20 years, but approximately 50% of the juveniles and 22% of the adults die each year.

In good habitat, nesting densities range from 1.8 to 0.2 pairs/km^2 (4.68-0.52 pr/mi^2). Most Red-shouldered Hawks do not breed until they are two years old. More females than males breed in their first year, about 5% of the breeding females are yearlings. Reproductive success appears to be lower for Red-shouldered Hawks in northern Wisconsin, Michigan, and Minnesota than areas south. Most national forests in the north central states have surveyed at least some areas for Red-shouldered Hawks. Some have more than 20 years of research. Most are engaged in or are planning additional raptor surveys. Existing management and habitat protection as well as research priorities are summarized as part of this Conservation Assessment.

INTRODUCTION

The Red-shouldered Hawk (*Buteo lineatus*) is designated as a Regional Forester's Sensitive Species on Hiawatha, Huron-Manistee, Ottawa, Chippewa, and Chequamegon-Nicolet National Forests. It is

documented but not designated as a Regional Forester's Sensitive Species on the Mark Twain Shawnee, Hoosier, Wayne, Monongahela, Allegheny, Finger Lakes, Green Mountain and White Mountain National Forests in the Eastern Region of the Forest Service. This species occurrence is documented but listed as a Species of Special Concern on the Mark Twain National Forest. Although surveying has occurred, the Red-shouldered Hawk has not been documented on Superior National Forest or Midewin National Tallgrass Prairie.

Regional Forester's Sensitive Species Risk Evaluations for national forests in Minnesota, Wisconsin and Michigan all rated abundance, distribution and population vulnerability as high or moderate risk factors. These evaluations indicate that Red-shouldered Hawks were rare or uncommon, had a restricted to localized population or were at the periphery of range, and were fragile to somewhat resilient. Population trend and habitat integrity were rated as moderate or low risk factors, thus indicating a suspected decline or stable population on the national forests of Michigan, Wisconsin, and Minnesota, and a need for some protection or special management on these national forests. Overall rationale for listing included: uncommon to rare on forest; forest is at edge of its range, but still harbors a viable population. Additionally, Red-shouldered Hawks are sensitive to predation, competition, habitat disturbance (primarily logging), and have exhibited marginal reproductive success. It is listed as a state threatened species in Michigan and Wisconsin and species of concern in Minnesota, and as a Region 3 U.S. Fish and Wildlife Service resource conservation priority. Furthermore, researchers have documented declines in population and habitat loss for several states.

The purpose of this document is to provide the background information necessary to prepare a Conservation Approach that will include management actions to conserve the species. Minnesota, Wisconsin, Michigan, Ohio, Indiana, Illinois, and Missouri will be referred to as north central states and will be the general area of focus for this document. The national forests of these states, especially Minnesota, Wisconsin, and Michigan, will be the specific focus.

General breeding bird surveys do not detect breeding raptors very well. Conspecific callback surveys have been shown to be the most effective method of surveying for breeding raptors. These surveys can also help locate active nests.

ACKNOWLEDGEMENTS

This assessment has benefited from the information published in several comprehensive reviews on the biology, status, and management of Red-shouldered Hawks as well as state breeding bird atlases, numerous journal articles, comments from forest service biologists and Red-shouldered Hawk researchers, and 30 years of personal field experience with these hawks by the authors. The authors wish to thank the people who reviewed this document or responded to requests for information (listed on pages 98-99) especially: Nancy Berlin, John Casson, Kevin Doran, Kenneth Ennis, Thomas Erdman, Robert Evans, Kathy Flegel, William Glass, Jeff Hays, Mary Lane, Edward Lindquist, Kelle Reynolds, Michael Spanel, and Norm Weiland.

NOMENCLATURE AND TAXONOMY

RED-SHOULDERED HAWK

Phylum: Chordata, Class: Aves, Order: Falconiformes, Family: Accipritridae, Genus: *Buteo,* Species: *Buteo lineatus*, Subspecies: *Buteo lineatus lineatus*. (Gmelin 1788)

The American Ornithologist Union (AOU), and most authors, recognize the nominate race of the Red-shouldered Hawk as *Buteo lineatus lineatus* (AOU 1983). Palmer (1988) felt Red-shouldered Hawks fit better morphometrically in the genus *Asturina* than in *Buteo. Buteo lineatus* and *Buteo ridgway* may constitute a superspecies (AOU 1983), but the relationship has not yet been studied genetically. Debate continues about placement of *lineatus* in genus *Asturina* or *Buteo* (Millsap 1986, Amadon and Bull 1988, Crocoll 1994).

Five subspecies have been recognized by the AOU: *lineatus, alleni, extimus, texanus, and elegans* (AOU 1983).

The subspecies that occurs in the north central states, and the focus of this document, is the Eastern Red-shouldered Hawk (*Buteo lineatus lineatus*). The other four subspecies occur in the United States,

and are slightly smaller in size with minor color variation. All subspecies are described below in section # 5, and will be referred to occasionally throughout this document to support information on *lineatus.*

DESCRIPTION OF SPECIES

The Red-shouldered Hawk is a medium sized raptor that exhibits reverse sexual dimorphism (females are larger, but to a lesser degree than accipiters). Males measured in total length 43-58 cm (17-23 in) and females 48-61 cm (19-24 in)(Crocoll 1994). Mass from breeding birds found males and females averaged 550g and 701g respectively in Michigan (Craighead and Craighead 1956) and 544g (486-582) and 670g (593-774) respectively in Wisconsin (J. & E. Jacobs in Crocoll 1994).

Adult Plumage (See images above) Dark brown dorsally with black and white bands on the flight feathers. Ventrally the breast and belly are colored with orange, pale orange or rusty reddish horizontal barring. Upper lesser wing coverts ("shoulders") are rusty brown. Tail is relatively longer when compared to other eastern *Buteos* with (when viewed dorsally) three distinct narrow white bands (approx.1 cm wide) separated by wider (approx. 3 cm) corresponding black bands. Cere, legs, and feet are pale yellow to orange in color. The iris color is dark brown (pers. obs.).

Juvenile Plumage (See images below) Fully developed shortly after fledging (42 days old) and retained until the following breeding season (14 months old) (pers. obs.). Dorsally, lighter shades of brown than adult, with a hint of rust on lesser upper wing coverts. Ventrally, buffy with vertical brown streaking throughout, but heavier anteriorly. Tail lacks the distinct narrow white bands as in adults. There are dark transverse bars separated by narrow bars of pale shades of gray or tawny brown. Cere, legs and feet vary in color from a pale yellow to pale pastel greenish-gray (Clark & Wheeler 1987). The iris color is grayish as a fledgling and progressively gets darker, turning dark brown usually by 2 years of age (pers. obs.).

In flight Flight is similar to that of other buteos with a series of 3-7 quick, stiff, shallow flaps and a glide, with somewhat faster flaps and shorter periods of gliding than the Red-tailed Hawk (Palmer 1988). Red-shouldered Hawks soar with wings slightly bowed and glide with wings bowed (Sibley 2000). From below, they have translucent crescent shaped white patches at the base of their primaries ("windows"), whiter and more visible in adults, tawny in juveniles. Underwing coverts are uniformly rufous in adults; pale and more streaked in juveniles. From above, adults have contrasting narrow white bands separated by wider black bars along the flight feathers. This is lacking in juveniles (Clark & Wheeler 1987, per obs.).

Similar species In flight, Red-shouldered Hawks are slightly larger in size than female Cooper's Hawks (*Accipiter cooperii*), but have a shorter tail and longer wings. Red-shouldered Hawks are more often confused with the smaller Broad-winged Hawk (*Buteo platypterus*), which lacks the black and white bands on the flight feathers. The white tail bands on the Broad-winged Hawk are much wider and fewer, usually only one white band is visible from underneath compared to the two or three on Red-shouldered Hawks (Clark & Wheeler 1987).

Voice The call of a Red-shouldered Hawk is easily distinguished from other raptors. They have a two syllable *Kee-aah* call, with the accent on the first syllable and a falling inflection on the second (Palmer 1988). Vocalization varies, but is usually a series of *Kee-aah* calls repeated 5-12 times followed by 10-25 seconds of silence, then another series of 5-12 calls followed by 2-12 min, or more, of silence (Jacobs, in Crocoll 1994). This call is most often heard during the preincubation period to define territorial boundaries. This same call is used to denounce an intruder from the nest area. After incubation starts the birds become quieter except during prey deliveries by the male when a few quieter, abbreviated calls can be heard. A *Kip* call is often used during food transfer (pers. obs.).

Nestling calls During their first week of life nestlings can emit a two note peeping call. At 2-3 weeks of age they are capable of the adult call but it's usually shorter in duration and weaker in volume (Crocoll 1994, pers. obs.). Near fledging, the nestlings can often be heard calling from the nest. At this age their call can be easily confused with an adult call (pers. obs.).

DESCRIPTION AND RANGE OF SUBSPECIES

Eastern Red-shouldered Hawk, *Buteo lineatus lineatus* (Gmelin), or sometimes called Northern Red-shouldered Hawk, breeds in eastern United States and southern Canada, including eastern Nebraska, north central Minnesota, Wisconsin, Northern Michigan (Isle Royale, Sault Ste Marie), southern Ontario (Parry Sound and Muskoka districts), southern Quebec, and Maine, south to southern Kansas, eastern Arkansas, Tennessee, and North Carolina (AOU 1983).

Most Red-shoulders that breed in the northern states winter in the southern half of the range listed above. A few birds occasionally winter as far north as southeastern Minnesota and in the southern half of Wisconsin, Michigan, New York, and New England (AOU 1983, Sibley 2000, LeBaron 2000).

Florida Red-shouldered Hawk, *Buteo lineatus alleni* (Ridgway), similar to *lineatus* but smaller and paler, adults with very pale breast, pale gray head and grayish back. Its tail has fewer (2 or 3) white bands. Juvenile *alleni* are similar to *lineatus* juveniles but smaller, ventrally cream color, heavily streaked and barred with brown, dorsally tawny brown. Resident from eastern Texas and Oklahoma east to South Carolina and most of Florida (AOU 1983).

Insular Red-shouldered Hawk, *Buteo lineatus extimus* (Bangs), adults similar to *alleni* but smaller and paler, the palest overall, with darker tail bands. Juveniles are pale cream color with light, fine, brown streaking ventrally, and light tawny brown dorsally. Resident in extreme southern Florida from Lake Okeechobee to the Florida Keys and the Dry Tortugas (AOU 1983). Their range overlaps with *alleni* in south Florida (Wheeler & Clark 1995).

Texas Red-shouldered Hawk, *Buteo lineatus texanus* (Bishop), generally smaller with adults more colorful than *lineatus*, rich rufous cast overall, breast is bright cinnamon rufous, abdomen and lower tail coverts are a bright buff heavily barred with cinnamon rufous. Juveniles are almost identical to juvenile *alleni*. Resident from central south Texas (Austin, San Antonio, and Corpus Christi) south along the Gulf Coast to Veracruz and the Distrito Federal of Mexico (AOU 1983). Range in Mexico needs further verification (Palmer 1988).

California Red-shouldered Hawk, *Buteo lineatus elegans* (Cassin), formerly called Red-bellied Hawk, is the most brightly colored subspecies. Adults have their entire breast and belly a bright rufous orange. The shoulder patch is brighter rufous and it has wider white tail bands than *lineatus*. Juveniles are much different from juveniles of other subspecies, being more adult-like. Ventrally, buffy• heavily barred with brownish spades; dorsally, rich rufous brown with whitish markings in wings and tail similar but not as bright as adult (Palmer 1988). Resident from Oregon south along the coast west of the Sierran divide, chiefly in the San Joaquin and Sacramento valleys and the southern coastal lowlands of California, south to Baja California Norte, Mexico (AOU 1983). Most *elegans* are nonmigratory (Crocoll 1994).

Illustrations and descriptions of *lineatus, alleni,* and *elegans* can be found in Sibley (2000), and Clark & Wheeler (1987). Wheeler & Clark (1995) has excellent photographs of all subspecies of juveniles and four subspecies of adults.

PREY AND HUNTING METHODS

Prey Items The wide range of prey items consumed by Red-shouldered Hawks is well documented in the literature. Prey deliveries at monitored nests found small mammals (*Mammalia*) and herps (*Reptilia* and *Amphibia*) to be the two most common categories of prey items delivered to nests (Penak 1982, Portnoy and Dodge 1979, Janik and Mosher 1982, Welch 1987)(Table 10). In Wisconsin, Welch (1987) reported the four mammals most frequently delivered to Red-shouldered Hawk nests were chipmunks (14), meadow voles (13) red-backed voles (9), and deer mice (8). Fish (*Osteichthyes*) were reported from only three studies, all in Wisconsin (Welch 1987, J. Steffen pers. comm., J. & E. Jacobs unpub. data).

The more common prey items reported include mammals, reptiles, amphibians, birds, and invertebrates.

*Mammal*Eastern Chipmunk (*Tamias striatus*) Meadow Vole (*Microtus pennsylvanicus*) Boreal Red-backed Vole (*Cethrionomys gapperi*)
Short-tailed Shrew (*Blarina brevicanda*) Deer Mouse (*Peromyscus maniculatus*) Masked Shrew (*Sorex cinereus*)
Meadow Jumping Mouse (*Zapus hudsonius*)
Eastern Mole (*Scalopus aquaticus*)
Star-nosed Mole (*Condylura cristata*)
Reptiles
Five lined Skink (*Eumeces fasciatus*)
Race Runner (*Cnemidophorus sexlineatus*) Snapping Turtle (*Chelydra serpentina*) Eastern Garter Snake (*Thamnophis sirtailis sirtailis*)
Smooth Green Snake (*Opheodrys vernalis*) Red-bellied Snake (*Storeria occipitomaculata*)
Northern Water Snake (*Nerodia sipedon*) *Amphibians*
Green Frog (*Rana clamitans*)
Northern Leopard Frog (*R. pipiens*)
Wood Frog (*R. sylvatica*)
American Toad (*Bufo americanus*)

salamanders (*Ambystoma spp*.)
Birds
Common Grackle (*Quiscalus quiscula*)
Red-winged Blackbird (*Agelaius phoeniceus*)
Northern Oriole (*Icterus galbula*)
Yellow-shafted Flicker (*Colaptes auratus*) Mourning Dove (*Zenaidura macroura*)
Invertebrates
earthworm (*Lumbricidae spp*.)
crayfish (*Astacidae spp*.)
grasshoppers and crickets (*Orthoptera*) spiders (*Arachnida*)

The primary food item can vary from area to area or year to year. In Michigan, Craighead and Craighead (1956) found herps and birds were delivered slightly more frequently than small mammals. The Red-shouldered Hawk's ability to change from one prey type to another in subsequent years is reported by Bednarz and Dinsmore (1985). During a drought year, small mammals comprised 92% of the prey items delivered to Red-shouldered Hawk nests in Iowa. During the following season (same study area) with standing water covering most of the nesting territories, amphibians and arthropods comprised 85% of the prey items delivered to nests. Penak (1982) also found a significant change in prey items, between mammals and non-mammals in successive years. Over two years, no significant differences were found in the rainfall amounts and therefore did not appear to contribute to their change in diet (Penak 1982).

In Maryland, Henny et al. (1973) could not find a significant correlation between reproductive rates of Red-shouldered Hawks and precipitation amounts during the breeding season. No doubt, densities of prey species will vary from year to year. Limited studies have shown the Red-shouldered Hawk can adapt to available prey without sacrificing reproductive performance (Bednarz and Dinsmore 1985). They suggest that Red-shouldered Hawks are flexible and do not rely on a specific prey, but instead will adapt to the available prey within their home range. This is supported by the variety of prey items found in the Red-shouldered Hawk's diet.

Low prey numbers or competition with other predators in their home range might directly or indirectly be the cause of low reproduction or wide annual reproduction in northern Wisconsin (J. Jacobs 1997). Further study is needed on prey fluctuations and how it affects Red-shouldered Hawk reproductive performance.

Portnoy (1974) Janik (1980) and Morris (1980) speculate that the Red-shouldered Hawk nesting cycle coincides with the breeding cycle of the Eastern Chipmunk. In Wisconsin, chipmunks emerge from hibernation about the same time Red-shouldered Hawks return to the breeding sites (Table 6 and 7). The range of the Eastern Chipmunk is similar to that of the Eastern Red-shouldered Hawk. Both typically inhabit forested areas. Chipmunks are a very common and available small mammal and are large enough that one individual provides a substantial amount of food. This diurnal mammal feeds primarily on seeds, nuts, and berries, and therefore its populations rise and fall with the availability of food.

To understand the importance of any individual prey species, the biomass of all prey species should be used when conducting food habit studies. The mass of a chipmunk is greater than most other prey items and is likely of greater importance to the Red-shouldered Hawk's diet than indicated by published studies.
Areas of moist forest, forested wetlands, and free water are necessary for many prey items such as fish, crayfish, turtles, amphibians and several species of mammals such as star-nosed mole, red-back vole, woodland and field voles, and shrews.

Habitat requirements of primary prey species will not be addressed because it is beyond the scope of this document.

Seasonal Dietary Shifts Although most Red-shouldered Hawks from Minnesota, Wisconsin, and Michigan migrate south, a few will remain through the winter (Robbins 1991, pers. obs, Sibley 2000). Seasonal shifts in diet are likely a function of prey availability. Most studies reported food habits during the nesting season when adults return with food to feed their young. During late summer, both adult and juvenile birds were occasionally observed hunting from low (2-7 m) perches in small (<3 ha) grassy fields in pursuit of invertebrates (pers. obs). During winter, in northern states the Red-shouldered Hawk's diet is restricted to mammals, birds, and carrion. In Wisconsin, wintering Red-shouldered Hawks were observed feeding on Mourning Doves *(Zenaida macroura),* European Starlings (*Sturnus vulgaris*), and House Sparrows (*Passer domesticus*) (Jacobs in Crocoll 1994), but overall small mammals make up the majority of their winter diet (Craighead and Craighead 1956). Several Red-shouldered Hawks have recently been reported eating suet at feeders during winter, demonstrating the ability to acquire new feeding habits (E. Jacobs pers. obs.).

Foraging Behavior, Success and Prey Delivery Rates
Foraging Behavior In Missouri, Parker (1986) observed Red-shouldered Hawks hunting from perches 2-4 m high using the "perch and wait" method. Attack flights were short and quick. Occasionally the birds were seen searching for prey items in ground vegetation. Often these hawks were found foraging near small (temporary or permanent) sources of water in most habitats, catching prey within one meter of the water's edge.

Foraging Success No Data. Direct observation of hunting success rates are difficult during the summer months due to forest cover.

Prey Delivery Rates From data collected using movie cameras, Portnoy and Dodge (1979) reported approximately 10 prey deliveries/day when the young were 10-16 day old. They found prey deliveries to nests increased throughout the morning hours, peaked between 14:00 – 16:00 and then continued to decline as the afternoon progressed. These results may be related to prey activity. Herps and invertebrates become more active as the temperature rises, making them more visible and therefore more vulnerable to hawk predation (Craighead and Craighead 1956).

In Quebec, Penak (1982) found nests with broods of three young received more prey deliveries of a greater mass than those nests with only one young. She also reports the number of prey deliveries per nestling progressively decreased as the brood size increased from one to four young.

Maximum Foraging Distance from Nest As reported previously, diet can vary among areas and even between years for the same area (Bednarz and Dinsmore 1982). Therefore, the distance from the foraging area to the nest would likely vary in relation to the surrounding habitat. Telemetry studies (McCrary 1981, J. Jacobs & T. Erdman unpub. data) have shown differences in foraging distances between males and females during incubation and early nestling periods. They found the male spends more time foraging farther from the nest during preincubation and early nestling time than the female. This is probably related to the female's responsibility for incubation, brooding, and feeding the young. Her distance significantly increases during the late nestling and fledgling periods.

On the Nicolet National Forest, males foraged only slightly farther than females during the total breeding period, 1.6 km (1mi) maximum foraging distance for males, compared to 1.5 km for females (J. Jacobs & T. Erdman unpub. data).

Prey Caching Caching is infrequent, but Red-shouldered Hawks have been reported to cache and retrieve prey items near the nest (Bednarz in Palmer 1988, Hays pers. comm.). No other data is available.

HABITAT

Breeding Season Habitat

Water Water is a critical element of Red-shouldered Hawk habitat. Breeding Red-shouldered Hawks are found in riparian, bottomland, swampland, wet or moist forests or upland forests adjacent to ephemeral or permanent ponds, wetlands, swamps or streams. Almost all Red-shouldered Hawk studies reported water or wetlands as an important habitat characteristic (Bent 1937, Hands et al. 1989, Peterson et al. 1992, Crocoll 1994, Dykstra et al. 2001a). The importance of water and wetlands is supported by the high percent of herps in the Red-shouldered Hawk's diet. Several studies found fish and crayfish in their diets (Craighead and Craighead 1956, Welch 1987, pers. obs.). Bednarz and Dinsmore (1982) state Red-shouldered Hawks have probably adapted to utilize the forest floodplain habitat rather than being dependent on the water per se.

Dominant Forest Types Almost all studies reported Red-shouldered Hawk nesting habitat as mature, contiguous, hardwood forests of large pole or sawtimber size trees. Examples of habitat types for northern and eastern United States include old-growth or mature forests of:

beech-maple-basswood
hemlock-beech
northern mesic
southern mesic
conifer-hardwood
southern-hardwood
temperate deciduous
yellow birch-maple-oak
eastern hardwood
mixed-hardwood-conifer
river floodplain
river bottom
swamp hardwoods
yellow birch-hemlock-beech

(Bent 1937, Hands et al. 1989, Peterson et al. 1992, Crocoll 1994)

Several studies have measured breeding season habitat characteristics throughout eastern United States (Bednarz and Dinsmore 1982, Titus and Mosher 1987, Crocoll and Parker 1989, Dykstra et al,

2000, Cuthrell and Cooper 2001, Jacobs and Hnilicka unpub. data). Riparian areas of bottomland hardwoods forests were reported by many researchers (Stewart 1949, Henny et al. 1973, Bednarz and Dinsmore 1981, Kimmel 1981, Stravers 1989, Jacobs and Jacobs 1997) along with upland stands of deciduous or mixed deciduous/conifer forests (Titus and Mosher 1981, Armstrong and Euler 1982, Crocoll and Parker 1989, McLeod et al. 2000). Preston et al. (1989) felt that nest tree species for Red-shouldered Hawks was less important than site location and stand structure.

Forest Structure, Stand Age, Tree Size and Density Tree size and structure appear to be more important than stand age. Often many trees in the immediate stand of the nest tree were 17-40^{+} cm (7-16 in) dbh and approximately 40-200 years old. Most studies reporting habitat did not give specific data on age of forested stands but generally reported the stand as mature, large pole size, or sawtimber size. In Michigan, Cuthrell and Cooper (2001) found nests in forests of pole size trees of 6-9 inch dbh. Belleman and Andersen (1996) reported the average age of nest trees in Camp Ripley, north central Minnesota as 60 to 66 years old. Research in Wisconsin found nests in stands of approximately 40 to 50+ years old (J. & E. Jacobs unpub. data).

Canopy Closure Canopy closure appears to be a critical nest-site characteristic. Many Red-shouldered Hawk studies reported closed-canopy as a habitat characteristic and/or recommended maintaining a canopy closure > 70% for the nesting habitat (Kimmel & Frederickson 1981, Titus & Mosher 1981, Bryant 1986, Woodrey 1986, Preston et al. 1989, Dijak et al. 1990, Szuba et al. 1991, J. & E. Jacobs 2000). However, while these studies found Red-shouldered Hawks nesting in a closed canopy forest, many did not show that canopy closure is a critical nest-site characteristic by comparing canopy closure at nest sites to random sites, others found no significant difference between nest sites and random sites.

Open canopy and forest fragmentation enables Red-tailed Hawks and Great Horned Owls to displace or kill Red-shouldered Hawks (Bryant 1986, J. & E. Jacobs unpub. data). Bednarz and Dinsmore (1982) found Red-shouldered Hawks nesting in taller trees with a greater dbh and in areas with a higher canopy cover than Red-tailed Hawks. They suggested forest fragmentation and loss of forested areas to agriculture as likely causes for intrusion of Red-tailed Hawk into Red-shouldered Hawk nesting areas.

In Canada, Bryant (1986) found even when woodlot size and total forested areas remained constant, Red-tailed Hawks had replaced Red-shouldered Hawks from historical sites. Bryant found these sites had decreased tree densities and canopy closure in response to selective cutting (removal of largest trees thus opening up the canopy). He believed that Red-tailed Hawks could not displace Red-shouldered Hawks from even small wood lots <5ha provided the stand maintained high (>70%) canopy closure. This study monitored nests in woodlots surrounded by agricultural/urban habitat in southern Ontario. In extensive forest habitat of Wisconsin, Red-tailed Hawks displaced or killed Red-shouldered Hawks from nesting habitat and took over the nest Red-shouldered Hawks had used the previous year even when the immediate area around the nest tree had not been logged but areas within 100 meters had been extensively logged, sometimes clear cut (J. Jacobs unpub. data).

At nest sites in Wisconsin, Jacobs and Hnilicka (unpub. data) sampled 0.04 h (0.1 acre) plots centered around the nest tree and found average canopy closure of 70% with 11.8 overstory trees per

0.04 ha (118 per acre) plots. In lower Michigan, Cuthrell and Cooper (2001) found an average canopy closure of 88% for 44 nests. In the U.P. of Michigan, Christiansen (1998) found Red-shouldered Hawk nests in stands with dense canopy cover (median 95%), far greater than what was found for Red-tailed Hawks.

Very few studies found Red-shouldered Hawks using fragmented areas. Craighead and Craighead (1956) found Red-shouldered Hawks to be the most common nesting raptor in southern Michigan during the 1940's. Although only 11% of the total study area was forested, Red-shouldered Hawks managed to "hang on" for several years before being replaced by Red-tailed Hawks (Craighead and Craighead 1956, S. Postupalsky pers. comm.). In a suburban area of Ohio, Dykstra et al. (2000) found high densities of Red-shouldered Hawks in areas that are 45-50% forested, with reproductive performance similar to rural sites. But they also caution that Red-shouldered Hawk populations there might be lower than 25 years ago and they are losing nesting sites to development.

Aspect, slope and landscape features most studies found nest sites located on flat or low to moderately sloped land. Aspect and slope vary between studies and within the same study area. Although some sites were in hilly or ravine areas, most sites were on land sloped less than 10%. Belleman and andersen (1996) found red-shouldered hawk nests on slopes that varied from 2-26%, with a mean slope of 9.4% for 39 nests in central minnesota. Cuthrell and cooper (2001) found some nests on steep slopes in michigan. Bosakowski et al., (1992) reported a mean slope of 5.3% for 14 nests in northern new jersey. Dykstra et al. (2000), found a mean slope of 7.7% (n=33) and 5.6% (n=30) for two study areas in ohio. Bednarz and dinsmore (1981) reported little if any slope at nest sites. Portnoy and dodge (1979) reported east and northeast slopes in mature deciduous forest.

Small Forest Openings Although forest openings are not necessary for Red-shouldered Hawk nesting, small openings (<4 ha) might increase foraging prey species numbers or accessibility. Many forest openings already exist on national forest (logging roads, blow downs, nonforested wetlands and swales, etc.). Creating more openings might fragment the forest and invite competitors/predators like Red-tailed Hawks and Great Horned Owls. In lower Michigan, Cuthrell and Cooper (2001) found Red-shouldered Hawk nests close to upland openings, but cautioned that an increase in forest fragmentation could result in an influx of Red-tailed hawks and Great Horned Owls. Bednarz and Dinsmore (1981) suggest making small openings of <4ha, provided these cuts do not exceed more than 15% of the forested area while maintaining a continuous track of forest to prevent the intrusion of Red-tailed Hawks. More research is needed regarding the importance of forest openings and their impact on Red-shouldered Hawks.

Nest Site, Nest Tree, Nest Structure, and Location in Tree Most studies found the nest located approximately 17m (56 ft) high in the main crotch of a large, live, deciduous tree supported by three or four branches (Bednarz 1979, Apfelbaum and Seelbach 1983, Titus and Mosher 1987, Palmer 1988, Crocoll and Parker 1989, Ebberts 1989, Dijak et al. 1990, Cuthrell and Cooper 2001, J. & E. Jacobs, unpublished data). The nest tree was often one of the largest trees within the sample plot. Nest tree heights averaged more than 24 m (79 ft) high with a dbh of 50 cm (20 in) or more and a basal area within the 0.04 ha plot of 27.5 to 34.2m^2 (Table 11). These studies found Red-shouldered Hawks using hardwoods much more frequently than conifers even though both were available in the area.

Nest Site Specific nest site characteristics have been studied in several states (cited above and Table 11). These studies found nests were generally built about one half to two thirds of the way up the tree, but below the canopy and were often less than 100m from water.

Nest Tree Red-shouldered Hawks selected nest trees that were taller and had a greater dbh when compared to a random sample of trees in the general area (Titus and Mosher 1987, Dykstra et al. 2000, Cuthrell and Cooper 2001). Sixty- three percent of the Red-shouldered Hawk nest trees were greater than 40 cm dbh (16 in), whereas less than one percent of the random trees were this large (Titus and Mosher 1987).

Nest Tree Species Over 43 species of trees have been reported as nest trees. Nests were most often reported in: American Beech (*Fagus grandifolia*); Maples (*Acer spp.*); Oaks (*Quercus spp.*); Birch (*Betula spp.*); Aspens (*Populus spp.*); and, Pines (*Pinus spp.*) (Hands et al. 1989, Crocoll 1994). In Wisconsin, Red-shouldered Hawks were found nesting most often in deciduous trees (Jacobs et al. 1988). Of 304 nests: Red Oaks (*Quercus rubra*) were used most frequently (34%); followed by Quaking Aspen (*Populus tremuloides*) 14%; American Beech 11%; White Birch (*Betula papyrifera*) 10%; Sugar Maple (*Acer saccharum*) 8%; White Oak (*Quercus alba*) 7%; Bigtooth Aspen (*Populus*

grandidententata), Yellow Birch (*Betula alleghaniensis*), Eastern Cottonwood (*Populus deltoides*), White Ash (*Fraxinus americana*), White Pine (*Pinus strobus*), and others were all <3% each. In Michigan, Cuthrell and Cooper (2001) found: 41% in Am. Beech, 21% in maple spp., 12% in Aspen, 10% in White Birch, 6% in Basswood, and all other tress <3% each (n=130).

Nest This bulky, mostly flat structure is built almost entirely of sticks with a top surface area of 2862 cm^2 and located one-half to two-thirds of the way up the tree (Morris & Lemon. 1983). In Wisconsin, 350 nests average 70 cm long x 53 cm wide x 35 cm high or thick (28 in x 21 in x 14 in) (J. & E. Jacobs unpub. data).

The top of the nest is usually decorated with conifer sprigs (White Pine, Eastern Hemlock) except in areas where conifers do not occur, while the nest cup is often lined with birch bark, leaves, moss and lichens (J. & E. Jacobs unpub. data). Other materials reported include, straw, corn stalks, corn cobs, tissue paper, twine, dried tent caterpillar webs, and nests of songbirds (Palmer 1988, Crocoll 1994). After the eggs hatch, fresh conifer and deciduous sprigs are periodically added to the top of the nest until the young fledge (J. & E. Jacobs unpub. data).

Alternate Nest Sites Alternate nests ($\geq$2 nests built the same season within the same territory) are occasionally found in Wisconsin (J. & E. Jacobs pers. obs.). They are found less frequently in eastern states (Crocoll 1994) and more often in Iowa (Bednarz in Crocoll 1994). Little is known about the importance of these nests. Perhaps they may be important for use in re-nest attempts should the original nest attempt fail early in the breeding season.

Suburban Nesting Most studies found Red-shouldered Hawks nesting in mature stands of forest far from human activity (Bednarz and Dinsmore 1982, Johnson 1989, Bosakowski, and Smith 1997). Only a few nests close to human dwellings have been reported (Eliason 1988, Campbell 1975, Dent 1994, Morris & Lemon 1983, and J. & E. Jacobs pers. obs). In southern California, Bloom et al. (1993), and Bloom and McCrary (1996), found Red-shouldered Hawks (*Buteo lineatus elegans*) nesting successfully in native and non-native trees near private residences in urban areas with significant human activity.

Until recently, this tolerance to large-scale human activity had not been reported for the eastern subspecies of the Red-shouldered Hawk until Dykstra et al. (2000) found 51 nests in a suburban area near Cincinnati, Ohio. The suburban Red-shouldered Hawks were similar in both productivity and nest site selection to rural nests. A very high nesting density of 1.2 pairs/km^2 was found in one portion of the study area, but it was not representative of the entire study area. They also reported losing nest sites to development.

Hays (2000) reported two rare examples of nesting on human made structures from the same study. Twelve young fledged during a three-year period from a nest built on the roof of a three story multi-family dwelling, and a nest built on top of a gas grill on the deck of an occupied residence. This nest failed when both adults stopped incubating the eggs.

Foraging Habitat Red-shouldered Hawks utilize a variety of habitats for foraging, but were most often found in forested habitats associated with water.

Several telemetry studies have reported Red-shouldered Hawks spend most of their time in forested

landscapes associated with water (Parker 1986, J. Jacobs & T. Erdman unpub. data), or in mature riparian areas (McCrary 1981). Dykstra et al. (2001b) found a variety of results while tracking Red-shouldered Hawks in a suburban setting in Ohio. One female spent 46% of her time in riparian/pond habitats. Two other birds (1 male, 1 female) never used riparian/pond habitats because these habitats were not within their home range.

Dykstra et al. (2001b) found Red-shouldered Hawks preferred natural habitats of forest, and wet areas and avoided suburban habitats when perching even though suburban areas made up more than 50% of their home range. Several studies reported small non-forested wet areas as primary foraging sites (Bent 1937, Stewart 1949, Portnoy 1974, Bednarz 1979, Kimmel and Fredrickson 1981).

Breeding Range Size The breeding range varied with studies and regions, ranging from 60 ha in California (McCary 1981) to as much as 339 ha in Maryland (Senchak 1991). Most other studies found breeding ranges from 90 ha to 175 ha (225 acres to 438 acres)(Bloom et. al. 1993, Parker 1986, J. Jacobs & T. Erdman unpub. data, Dykstra et al. 2001b.). Some studies found the breeding range size was dependent on the amount of suitable nesting and foraging habitat within their range. Birds with large tracts of unusable foraging habitat (asphalt, large clear cuts, or areas of intense human activity) had larger ranges than those without. (McCary 1981, J. Jacobs & T. Erdman unpub. data).

Most studies found the female's range was slightly smaller than (although not always significantly) and encompassed by that of its mate. Breeding range overlap between neighboring pairs usually varied from 6 to 11 % (McCary 1981, Dykstra et al. 2001b). A study of seven Red-shouldered Hawks on Lakewood District, Nicolet National Forest, 1989-1992, had breeding range sizes of 175 ha and 254 ha (438 and 635 acres) for the two most accurately determined ranges (J. Jacobs & T. Erdman unpub. data). In suburban habitat of Ohio, Dykstra et al. (2001b) found ranges, calculated using the adaptive kernel method (95% isopleth), averaged 90 ha for the breeding season, 189 ha for the non-breeding season, and 165 ha for the year-round home range (n= 11 for breeding season, n= 9 for non-breeding season). Males and females did not differ in range size.

Post Fledging Area The young range over a small area (50m radius from nest) immediately after fledging and continue to enlarge their range as they mature and develop their flight skills. During the first week post fledging, prey items are usually brought to the nest, where the fledglings quickly return and compete with siblings for the food. During the second, third and fourth weeks the young expand the distance (150 m radius) from the nest and eventually follow their parents to the hunting areas to develop hunting skills. They become self sufficient after six to eight weeks and disperse from their parent's breeding range (J. & E. Jacobs unpub. data).

The adults continue to range over the same area they did before the young fledged, but often become more sedentary because the demands for food by the young are reduced (J. Jacobs & T. Erdman unpub. data).

Winter Habitat Permanent resident birds in central and southern states will often occupy the same general habitat of lowlands near water, e.g. river valleys, marshes, and ponds (Palmer 1988). In southern Ohio (Hays pers. comm., Dykstra et al. 2001b), and probably in southern Indiana, Illinois, and Missouri, wintering Red-shouldered Hawks remain on an enlarged range that includes their summer

range.

The vast majority (>90%) of breeders from Michigan, Minnesota and Wisconsin migrate south during winter months. A few are reported in these states each winter on Christmas Bird Counts. Wintering birds in Wisconsin were found to frequent less forested areas than during the breeding season, but in habitat less open than Red-tailed Hawks (J. & E. Jacobs pers. obs.). Very few Red-shouldered Hawks were reported wintering in Wisconsin, Minnesota, or Michigan (Clark and Wheeler 1987, Sibley 2000). In 1999, during an extremely mild winter, only 12 were seen on Wisconsin Christmas Bird Counts, the highest total since 1978. Most were seen in the southern third of the state (Hilsenhoff 2000). Those that winter in Wisconsin usually are not in breeding ranges, but utilize different habitat: woodland edges; highway right-of-ways; parks; wooded suburban; and urban residential areas (pers. obs.). Bent (1937) also found that Red-shouldered Hawks that wintered in northeast states utilized different habitat than breeding birds.

DISTRIBUTION AND ABUNDANCE (RANGEWIDE AND REGIONWIDE)

Global Distribution Presently, Red-shouldered Hawks are widespread throughout its historic range with good numbers in prime habitat, but apparently much of its former breeding range is not inhabited (Peterson et al. 1992) (see maps 1 & 2). The breeding range of the eastern subspecies *B. lineatus lineatus, alleni, texanus,* and *extimus* are found in the eastern one-half of the United Sates. Ranging from north central Minnesota eastward across the northern states to Maine and including the southern parts of Ontario, Quebec and New Brunswick. Its range extends south to Florida, the Gulf Coast, southern Texas and eastern Mexico, including the valley of Mexico. The western sub species *B. lineatus elegans* breeds from southwestern Oregon south to northern Baja California of Mexico.

Buteo lineatus lineatus (Gmelin), Eastern Red-shouldered Hawk (see Maps 1 & 2), or sometimes Northern Red-shouldered Hawk, breeds in eastern United States and southern Canada, including New England states, central Minnesota, Wisconsin, northern Michigan (Isle Royale [AOU 1957, but not found in Michigan Breeding Bird Atlas], Sault Ste Marie), southern Ontario (Parry Sound and Muskoka districts), southern Quebec, and Maine, south to southern Kansas, eastern Arkansas, Tennessee, and North Carolina (AOU 1957, 1998).

This subspecies of Red-shouldered Hawk has been reported as a breeding bird on all national forests in the north central states except Midewin National Tallgrass Prairie and Superior National Forest. Hiawatha, Ottawa, Chequamegon-Nicolet, and Chippewa National Forests are all at the northern limit of its range.

Abundance Red-shouldered Hawks are believed to have been one of the most common hawks in its historic range prior to 1900 (Bent 1937, Hands et al. 1989, Peterson et al. 1992). A general major decline in Red-shouldered Hawk populations for the north central and northeast states is believed to have been caused by the major logging conducted during the 1800's and the early 1900's (Henny et al. 1973, Armstrong & Euler 1982, Bednarz and Dinsmore 1982, Brewer et al. 1991, Peterson et al. 1992). Additional declines also appear to have occurred during the mid 1900's (Brown 1971, Brewer et al. 1991). The loss of wetlands and the use of pesticides probably also contributed to the Red-shouldered Hawk decline. This decline appears to have ended in forested areas that were allowed to

mature from the logging conducted from 1850-1930 (Titus and Mosher 1981, Crocoll and Parker 1989, Peterson et al. 1992). Breeding Bird Survey data from northeastern states indicated no overall trend changes in Red-shouldered Hawk numbers from 1966-1987 (Titus et al. 1989). In New Hampshire the Red-shouldered Hawk was upgraded from a "Threatened Species" to a species of "Special Concern" after reported data found a nesting density of .4 pair/k^2 (1 pair/mi ^{2}) near Kensington. General Breeding Bird Survey (1966-1988) and Christmas Bird Count (1959-1988) long-term trends from across the United States showed a decline until 1966, but since 1970 have shown slightly increasing numbers, Figure 2 (Sauer et al. 1996). Using a more recent data set, 1980 – 1999, Sauer et al. (2000), found mid-west states (Wisconsin, Michigan and Illinois) with slightly increasing trend whereas Minnesota had a slightly decreasing trend (Table 12). However, Sauer et al. (2000), cautions that these analyses are in question because of very low abundance, very small sample size, or results that are not precise. Hays (pers. comm.) cautions Christmas Bird Count data is a poor indicator of winter Red-shouldered Hawk numbers (under counted) in southern Ohio.

State Breeding Bird Atlas results probably represent the most accurate and comparable information on breeding birds for most north central states. Table 9 compares the relative abundance of five woodland raptors (Red-shouldered, Broad-winged, Coopers, and Red-tailed hawks and Barred Owls) using Breeding Bird Atlas data for north central states. Red-shouldered Hawks had the lowest frequency of detection for almost every state, Broad-wings in Indiana and Coopers in Missouri were seen less frequently. No Red-shouldered Hawks were detected for large areas of each state (Map 1). Collectively Red-shouldered Hawks were seen on only 12% of Breeding Bird Atlas survey blocks for north central states (Table 9).

Wisconsin It is listed as a state threatened species. Robbins (1991) lists it as an uncommon summer resident, although it can be found in greater numbers in mature stands of river bottomland forests. Red-shouldered Hawks have been reported as possible breeders from approximately 72% of the counties across the state, but less frequently in the southeastern one-third of the state where agriculture areas are dominant (Map 1). It was one of the rarest hawks reported in the Breeding Bird Atlas, it was seen on only 14% of the blocks.

Chequamegon-Nicolet Regional Forester's Sensitive Species Risk Evaluation (Adams & Matthiae 2000) listed Red-shouldered Hawk abundance as rare, but it might be locally common in prime habitat. Nicolet National Forest has identified 75 nest sites and an estimated population of 200-250 breeding pairs. It has been estimated that only one-half of Nicolet National Forest has suitable Red-shouldered Hawk habitat. (J. Jacobs 2001, Erdman & Jacobs 1994).

Michigan It is listed as a state threatened species. Red-shouldered Hawks were once considered a common breeder (Ebberts, in Brewer et al. 1991) in the southern part of the state. Since the 1940's, they have become far less common. The population center is now found in the northern half of the Lower Peninsula (Map 1). Peterson et al. (1992) reported Red-shouldered Hawks as a breeder across the Upper Peninsula, but at extremely low frequencies. Red-shouldered Hawks were reported for 17% of Breeding Bird Atlas blocks (Brewer et al. 1991). Cuthrell and Cooper (2001) suggest that Red-shouldered Hawks are a common breeder in state forests in the northern Lower Peninsula of Michigan.

Hiawatha National Forest Regional Forester's Sensitive Species evaluation (Sjogren & Prout 2000) rated abundance as uncommon, short term local population appears increasing, although it could be

from birds moving north from lower Michigan. Huron-Manistee National Forest Regional Forester's Sensitive Species evaluation (Ennis 2000) rated abundance as uncommon on national forest. Ottawa National Forest Regional Forester's Sensitive Species evaluation (Johnson & Evans 1999) rated abundance as rare, documented occurrence or population estimates on national forest are low.

Minnesota It is listed as a species of special concern. The Red-shouldered Hawk has never been listed as common and was not reported as a breeder until 1935 (Coffin & Pfannmuller 1988). Breeding records include Wabasha and Olmsted north and west to include Mahnomen, Becker and Hubbard counties. The estimated population for Minnesota is 200 breeding pairs.

Red-shouldered Hawks have not been reported for Superior National Forest. The Regional Forester's Sensitive Species evaluation for Chippewa National Forest (Russ 1999) rated abundance as rare, documented occurrence or population estimates on Chippewa National Forest are low, abundance unknown. They occur only in prime breeding habitat, not throughout the Chippewa (Casson pers. comm.).

Illinois It is listed as a state endangered species. The few primary breeding areas are restricted to the northern and southern parts of the state, otherwise only a few reports of nesting pairs across the state. The loss of mature stands of bottomland forest is the likely cause for decline of a species that was once considered a common breeder throughout the state (J. Herkert in Peterson et al. 1992).

Red-shouldered Hawks are considered a common breeding raptor in Shawnee National Forest (M. Spanel pers. comm.). They are not a breeding bird on Midewin National Tallgrass Prairie because of lack of habitat (W. Glass pers. comm.).

Ohio Red-shouldered Hawks have been designated as a species of special interest in Ohio. They are found in wet and mesic deciduous woodlands in Ohio. Formerly found statewide they are now restricted to southern and eastern Ohio. Jones (1903) considered them to be the most numerous large hawk in northern Ohio, but noted they were less common in the southern counties. The Breeding Bird Atlas recorded them in 17.3% of the priority blocks (Peterjohn and Rice 1991).

The Regional Forester's Sensitive Species evaluation (Flegel 1999) rated Red-shouldered Hawk abundance as uncommon, overall numbers low on Wayne National Forest. Sixty to three hundred and sixty pairs of Red-shouldered Hawks are estimated for Wayne National Forest (Flegel pers. comm.).

Indiana It is listed as a species of special concern. In the 1800's Red-shouldered Hawks were quite common breeders in the northern part of the state and less common as breeders in the southern part of the state (Butler 1898). The Breeding Bird Atlas (Castrale et al. 1998) showed the opposite to be true now, probably as a result of differential deforestation. Sixteen percent of the priority blocks reported Red-shouldered Hawks with the majority of them in the southern part of the state. A nesting population studied in southeastern Indiana declined about 18% each year from 1984-1994 (Webster and Chamberlain 1995).

Red-shouldered Hawk Regional Forester's Sensitive Species evaluation (Reynolds 1999) rated abundance as uncommon, 20+ Red-shouldered Hawks observed on Hoosier National Forest. They

were the most common woodland raptor detected on Hoosier National Forest in a raptor callback survey (Parker 1990).

Missouri It is classified as a state threatened species. Its range has shrunk from the historic range, which apparently used to extend farther north and into the southeast boot heel along the Mississippi River where extensive deforestation has occurred (R. Russell pers. comm.). Breeding Bird Atlas data showed them to be rare in the northern half of the state, more common in the southern half of state, with the greatest concentrations in the counties that border Arkansas. About 12% of blocks reported Red-shouldered Hawks statewide (Jacobs and Wilson 1997).

Red-shouldered Hawks are not on the Regional Forester's Sensitive Species list for Mark Twain National Forest. The 1986 Forest Plan listed Red-shouldered Hawks as rare, present in small numbers in Missouri. They are a locally common permanent resident to the Mark Twain National Forest area (M. Lane pers. comm.).

BIOLOGY AND NATURAL HISTORY

Annual Cycle, Chronology, or Phenology
Breeding Period
Pre-laying Period Red-shouldered Hawks usually return to breeding areas earlier in southern areas than in northern areas. Almost all Red-shouldered Hawks in Minnesota, Wisconsin and Michigan are migratory. Red-shouldered Hawks from these states start migrating to their nesting sites in mid February and arrive during March or possibly as late as the first week of April in the northernmost sites. Often snow is over 30 cm deep when they return. The few Red-shouldered Hawks that remain in these states have moved out of their breeding range and are wintering in a different habitat. In northeastern Wisconsin, Red-shouldered Hawks return about the same time as American Robins (*Turdus migratorius*) and Red-winged Blackbirds (*Agelaius phoeniceus*). The mean return date for this area is 7 March for 1996-2000 (Table 2 & 3). Chipmunks (*Tamias striatus*), a key prey item, emerge from hibernation about the time Red-shouldered Hawks return from migration (Table 2 & 3).

Courtship, territorial establishment, and nest building begin almost immediately after pairs return. Courtship lasts approximately from early March through mid April (pers. obs.). The male might arrive at the nesting territory first and defend the site while he attracts a mate. He might also be responsible for the first decorative evergreen sprig placed on an old nest in March before any other sticks have been added. (pers. obs. and interpretation). Nest building continues until incubation. Red-shouldered Hawks generally add more evergreen sprigs than any other hawk in eastern North America (pers. obs). In Wisconsin, rarely do they add any sticks or evergreens during mid-late incubation, and by the last week of incubation most or all of these evergreen sprigs on the nest have turned brown. However, Wood (in Bent 1937) stated that the majority of nests in Michigan are decorated after the eggs are advanced in incubation. Copulation starts shortly after the birds return to the breeding territory and usually occurs several times each day until after incubation has begun (J. & E. Jacobs unpub. data).

A refurbished nest, or one with fresh greens, is a sign that hawks have returned and are nesting even if the birds have not been seen or heard. However, even abundant greens are not conclusive evidence that

a particular nest will have eggs in it. They might not lay eggs or might build another nest as much as 700 meters away (pers. obs).

Hormonal secretions cause the female to lose the down feathers on her breast and abdomen and develop a brood patch, which will assist in the transfer of heat from her body to the eggs. These molted white down feathers often get caught on the sticks of the nest. Although there are exceptions, the presence of white down feathers on the edge of the nest is the conclusive evidence that eggs have been laid in that nest. However, Red-shouldered Hawks and other raptors will sometimes use an old nest as a feeding platform. So it is necessary to determine that the nest has been fixed up, greens have been added and the small feather is hawk down and not a feather from an avian prey item. A person approaching the nest during early incubation will often cause the female to quietly drop off the nest and fly several hundred meters away undetected. She often remains concealed and quiet until the person leaves. Or, she might give several series of kee-ah calls from hundreds of meters away, confusing the person into thinking that the active nest is hundreds of meters away in the direction of the calls. That one white down feather on the edge of the nest might be the only sign that the nest has eggs in it. As the incubation period progresses the female is less likely to leave the nest. Near the end of incubation she often hunkers down and remains on the nest until someone starts to climb the tree (pers. obs.). There is much individual variation in this behavior.

Incubation Period The eggs are elliptical or oval shaped with a smooth non-gloss surface texture, about the size of a large chicken egg, 54.58 x 43.33mm (Bent 1937, Crocoll 1994). They are very handsome with a base color of dull white or faint bluish tint overlaid with variable brown and lavender blotches, speckles, or other small markings (Palmer 1988). There are usually three and occasionally four eggs to a clutch, rarely 2 or 5 (Bent 1937, Robbins 1991). In Wisconsin, the first eggs are usually laid in early April (Table 6). Eggs are laid every two or three days (Bent 1937) so a complete clutch of 3 or 4 eggs could take 4-9 days.

Egg production is a big demand on the female; each egg is about 8% of her body mass. One 2-egg clutch mass averaged 16.8% of an adult female mass, while one 4-egg clutch averaged 30.6% (Crocoll 1994). Females need to have fat reserves and abundant food at the time of egg production. Small mammals like chipmunks, and amphibians like frogs appear to be critical food items for egg production each year. Frogs emerge from hibernation just before Red-shouldered Hawk eggs are laid (Tables 6 & 7).

Incubation usually begins before all the eggs have been laid (Bent 1937, Crocoll 1994, pers. obs.). Mean date 1996-2000 for onset of incubation is 15 April in northeastern Wisconsin (Table 6). Incubation lasts about 36 days (32-40 days- Craigheads 1954; 35-37 days- Portnoy & Dodge 1979; about 33 days- Palmer 1988, Crocoll 1994). The 28 days reported in Bent (1937) and some other literature appears to be incorrect (Palmer 1988, pers. obs.). The female does almost all of the incubation (Crocoll 1994, Palmer 1988, pers. obs.). The female develops a brood patch, is 20% larger, and because of hormones is better equipped physically and psychologically to incubate the eggs.

The male does not develop a brood patch but provides all the food for himself and almost all of it for his mate during incubation. He returns to the nest or near the nest with food, sometimes gives a kip call or a quiet abbreviated kee-ah call. The female leaves the nest, flies to his perch, takes the food while uttering

a twittering squeal, identical to the food begging calls of the young when being fed in the nest. She eats there or goes to another perch less than 100 meters away. The male goes to the nest and attempts to incubate the eggs while the female feeds. The female often uses this time to preen, defecate, stretch, loaf, or hunt, for as long as three hours while the male remains on the nest (Jeff Hays pers. comm., pers. obs.). Unless something has gone terribly wrong, the adults never defecate while at the nest (pers. obs.).

Nestling Period-Development of Young Nests often contain nestlings of different sizes and ages because eggs hatch asynchronously. In one 4 egg clutch there was a 5-7 day span between the first and fourth egg (Crocoll 1994). The mean hatching date for northeastern Wisconsin for 1996-2000 was 20 May (Table 2). The young are in the nest about 42 days (33-42 days; Craighead and Craighead 1954, 35 days; Penak 1982, 42 days; Portnoy and Dodge 1979, 45 days; Wiley 1975). Young grow very fast; hatching weight is about 35 g (Janik 1980, Penak 1982) and fledge weight about 470-690 g depending on gender. Female fledglings are larger and heavier than males(pers. obs.). Nestlings have two sets of down. The first is a yellowish white down followed later by a thicker wooly down that is white and thicker on the belly and grayish white dorsally (Bent 1937, Palmer 1988). Young back up and defecate over the edge of nest by their 5th day (Crocoll 1994). Fresh, wet defecation (called whitewash, or mutes) on the ground at the base of a nest tree is a good field sign that the nest has produced young. Remiges in sheaths (wing pinfeathers) start to appear at 14 days, and break through sheaths at 21 days. At 23 days, body feathers and tail begin to appear, young stand frequently and walk on digits. Head feathers appear at 26 days. The back is fully feathered first, then sides of breast, while the head is last. The wings grow 3-8 cm longer, the tail grows 5-12 cm after young leave nests. Weight increases most rapidly during the first 21 days. Weight of young levels off around 34 days as well as its demand for food (Crocoll 1994, Bent 1937, Penak 1982, Kennard 1894, pers. obs.).

Adult Behavior The female appears to do all the brooding. The amount of brooding is dependent on the age of the young and weather. She broods intensely for the first 10 days, frequently during the next 10 days and occasionally during the last 20 days. She spends more time brooding young in cold and/or rainy weather. The female returns to the nest to brood young at night until they are 30 days old (pers. obs.). The female remains at the nest to brood and protect the young for the first 10 days, then she starts hunting within 100 meters of the nest and by the time the young are 23 days old she has enlarged her range to 400m from the nest. She is usually close enough to intercept a food delivery from the male and deliver and feed it to the young. By the time the young are 25 days old, both adults usually just drop off the food at the nest and leave (Crocoll 1994, pers. obs.).

The male does most of the hunting until the young are 20 days old. By then the food demands are so great that the female is bringing in as much food as the male. The hungry brood forces the adults to fast; they are usually at their lowest annual weight during this period (pers. obs.).

Fledging-dependency Period Recently fledged juveniles remain close to the nest for the first 6-15 days. They develop their flight skills and muscles, and grow out their wings and tail. The first few days they return to the nest to feed and roost at night (Palmer1988). But by 12-20 days they are chasing adults for food and following them to their hunting areas. In Wisconsin, young are dependent on adults and remain in the breeding range of their parents for approximately 45-60 days after fledging (pers. obs.). They leave their parent's breeding range in mid-late August (pers. obs.).

One juvenile was captured at a banding station about 20-k northeast of its nest on 3 Sept. (Erdman pers. comm., Bird Banding Lab unpub. comm.). In California parents fed fledglings for 54-70 days. They were hunting insects 35 days after fledging and reptiles, amphibians, and mammals by 70 days (Snyder and Wiley 1976).

Non Breeding Period This is an important time for the adults to molt, regain weight, and prepare for migration and winter. Telemetry studies on Nicolet National Forest have shown that after the young fledge, the adults retire to swamps where they are relatively secretive and lethargic. They molt and regain the weight they have lost during the hectic previous month, and show their juveniles how to hunt (J. & E. Jacobs unpub. data).

Molt All Red-shouldered Hawks over one year old go through a complete molt between May and October. Although molt begins for the female during the incubation period (May), when she will molt 2 or 3 primaries, the heaviest molt occurs from July through September. The male usually starts molting in mid June and has completed his molt by October (pers. obs.). The adults are probably at their heaviest weight by October and maintain most of that weight through winter (pers. obs.).

MOVEMENTS

Migration Most, possibly more than 95%, of the Red-shouldered Hawks that summer in the national forest of Minnesota, Wisconsin, and Michigan migrate south in fall. While a very small percentage will winter in the same state, the vast majority of Red-shouldered Hawks will migrate 300-1,700 km to winter several states father south. Birds banded in Wisconsin migrated to the 8 states directly south. Data from 14 recoveries, Oct-Feb, showed: 6 from Illinois; 2 from Indiana; 1 from KY; 1 from TN; 1 from Missouri; 1 from Arkansas; 1 from Mississippi; and, 1 from AL (1932-1988 Bird Banding Laboratory, U.S. Fish & Wildlife Service data published in Crocoll 1994). Usually the juvenile Red-shouldered Hawks will migrate first in the fall, travel the farthest south, and return last to the breeding areas the following spring (pers. comm. T.C. Erdman, Bird Banding Laboratory□U.S. Fish & Wildlife Service, J. & E. Jacobs unpub. data). Red-shouldered Hawks, like most hawks, migrate south on a tail wind from the northwest after the passage of a cold front (Mueller & Berger 1961). Data from Cedar Grove Ornithological Station 1951-1996 (a hawk banding station along Lake Michigan just north of Milwaukee, Wisconsin) showed that although Red-shouldered Hawks migrate from 15 Aug-15 Dec., most are remarkably late migrants. Few individuals move before mid-October, with the peak migration occurring from 15 Oct-30 Nov. The peak flight day was 7 November 1991, when 58 were seen. Their best year for Red-shouldered Hawks was 1991, when 149 were seen. Only 3 individuals were seen in 1952 (Mueller, et al. 1997). Relatively few Red-shouldered Hawks are observed at banding stations compared to the large numbers of other hawks seen on migration.

Spring Migration Red-shouldered Hawks migrate north during February and March (Crocoll 1994), arriving on the breeding sites in Wisconsin in early March (pers. obs.). They usually migrate north on a tail wind from the southwest (pers. obs.).

DISPERSAL

Natal Dispersal Most hawks return to breed within 50 km (30 mi) of their birthplace, and females disperse farther than males (Newton 1979). Red-shouldered Hawks also return to breed very near their birthplace. In Wisconsin, 11 banded nestlings (six males, five females), later recaptured as breeding birds, dispersed an average distance of only 16.95 km (10.17 mi)(.38-80.5 km). Females moved farther than males. Five females averaged 26.63 km (2.4-80.5). Six males averaged 8.88 km (.38-17.76). One male returned to breed in his natal territory, but not at his natal nest. Most nestlings (73%) dispersed in a northerly direction (Jacobs and Jacobs 1995, E. Jacobs unpub. data).

All breeding season Red-shouldered Hawk band recoveries in eastern North America prior to 1988 were reviewed (99 recoveries). More than 54% of these recoveries were located within the same 10 minute block or in an adjacent block, i.e. less than 30 km from their natal site (Bird Banding Laboratory, U.S Fish & Wildlife Service unpubl. data). Most juveniles from non-migratory populations appear to remain within 30 km of their natal nest their entire life (J. Hays pers. comm.).

Breeding Dispersal The movement of Red-shouldered Hawks out of the breeding range seems to coincide with migration for the northern Red-shouldered Hawks. There is little data in the literature. (See also Migration and Non breeding period above.) Non migratory Red-shouldered Hawks in MD, California and Ohio remain on their breeding range or expand it slightly during the non-breeding season (Senchak 1991, McCrary et al. 1992, Bloom et al. 1993, Dykstra et al. 2001b). Red-shouldered Hawks in southern Illinois, Indiana, Ohio, and Missouri would probably behave similarly to the non-migratory ones cited above.

In Wisconsin, the juveniles disperse in any direction from their parent's breeding range in late Aug. They then continue moving as part of early migration, eventually moving south before the adults migrate. Dispersal is probably affected by wind direction. A nestling banded in Nicolet National Forest in June was recovered (found dead) near the state border of Missouri and Arkansas on 28 Oct (Bird Banding Laboratory, U.S. Fish & Wildlife Service, unpubl. data).

Telemetry studies on Nicolet National Forest show some adults remain within their breeding ranges through August. Red-shouldered Hawks have been observed on breeding ranges through October in Wisconsin. It has been assumed that most Wisconsin adults remain in their breeding range until migration (15 Oct-15 Dec)(pers. obs.).

Breeding Area Fidelity/Pair Fidelity Nesting territories are often used for decades, some even if the area has been disturbed (Bent 1937, Craighead and Craighead 1956, Dijak et al. 1990, J. Hays pers. comm., pers. obs.). Bent (1937) reported a territory used for 26 consecutive years for a site that has been occupied for at least 42 years until the woods were logged. He had observed another site that was occupied most of 47 years, and knew of another area that had Red-shouldered Hawks using it for over 50 years. One site in Wisconsin has been occupied for over 30 years, although an active nest has not been found every breeding season (pers. obs.). Several sites on Nicolet National Forest have been monitored for over 25 years, although an active nest has not been found every year. In 1993, at least 83% of Red-shouldered Hawk nest sites in Wisconsin were reoccupied (Jacobs and Jacobs 1993).

The average reoccupancy rate (percent of territories occupied the following breeding season) for Wisconsin during the years 1993-1997 was 66% (range 53%-83%)(Jacobs and Jacobs 1997). Cooper and Cuthrell (2000) reported a territorial reoccupancy average of 80% (range 78%-81%) for State Forests in Northern Lower Michigan for 1999 & 2000. In southwest Ohio, Dykstra et al. (2000) reported an average reoccupancy rate of 63% (range 61%-66%) for 1998 & 1999.

Nest Fidelity Reuse of the same nest as the previous year has also been shown to be very high for Red-shouldered Hawks. Sometimes the same nest will be used 2, 3, even 4 consecutive years. A new nest is often constructed within 150 m of the previous year's nest (Bent 1937, Craighead and Craighead 1956, Dijak et al. 1990, J. Hays pers. comm., Jacobs and Jacobs 1993.) In the State Forests of Northern Lower Michigan, nest fidelity was high during 1999 and 2000. Fifty percent of the nests utilized in each forest area during 1998 were reused during 1999 and 60% of nests utilized during 1999 were reused in 2000 for a two year average of 55% (Cooper and Cuthrell 2000). Dijak et al. (1990) in Missouri found a 35% reuse rate of nests in successive years. Jacobs et al. (1988) reported a 37% reuse rate for nests during the early 1980's. The best nest reuse year found for Wisconsin was 1993, of 60 nests used in 1992, 30 (50%) were reused (Jacobs and Jacobs 1993). At one site that has been monitored for 20 yr on Nicolet National Forest, the same nest has been used 6 consecutive years, and that nest has been used 10 out of the last 12 years. The active nest was not found two of the 12 years, but at least one hawk was at the site. Perhaps they did not lay eggs or lost a mate. Most Red-shouldered Hawk nests are not reused the following year on Nicolet National Forest (11% reuse rate, only 2 of 18 active nests reused in 2000). Sometimes the site is reoccupied but the new nest is not found (J. Jacobs 2000).

Pair Fidelity Red-shouldered Hawk pairs were "believed" to "mate for life" (Bent 1937) i.e. a pair remains together or reunites each breeding season at the same nest site until one of them dies. It was also believed that since hawks are long lived, a breeding pair would return for many breeding seasons. Based on a long-term study of over 100 nest sites in Wisconsin by J. & E. Jacobs (unpub. data), it appears most Red-shouldered Hawks return to the nest site they occupied during the previous year. The majority of nesting Red-shouldered Hawks will “disappear” from the nest site within 4 years. Only 10% will return to a site for 10 years or longer. If a Red-shouldered Hawk does not return, it probably has died. However, possibly 20% of these no-shows could have moved to another site (J. & E. Jacobs unpub. data, Dykstra et al. 2001b, J. Hays pers. comm.). Very little data has been published on this part of Red-shouldered Hawk population dynamics. Long term telemetry studies are needed.

SPATIAL STRUCTURE

Dispersion Red-shouldered Hawks use some areas year after year because these areas are superior Red-shouldered Hawk habitat. Even a national forest like Nicolet with a sizeable population of Red-shouldered Hawks does not have them evenly distributed throughout; but has areas of use and vast areas of nonuse. In this prime Red-shouldered Hawk habitat (described in section 6. Habitat) these hawks disperse themselves into the best nesting habitat, and defend a territory, excluding other Red-shouldered Hawks, except their mates, from this area. Often there is habitat adjacent to a nesting range or even within a nesting range that is of little or no use to the hawks and is seldom used.

Dispersion distances for nests in the best habitat on the Lakewood District southern Nicolet National Forest, were spaced approximately 1.30 km apart (n= 7, range .8-1.9 km). The closest two active nests we have found on Nicolet National Forest were 0.58 km apart. In northeast Wisconsin off Nicolet National Forest, in high quality habitat, the average distance from nest to nearest neighbor nest is 1.28 km (n= 7, range 0.75-1.65 km). The closest nests are 0.75 km apart. In central Wisconsin along the Wisconsin River we found an average distance of 0.79 km (n=4, range 0.76 km-0.84 km). Dykstra et al. (2000) found the nearest neighbor distance between nests in SW Ohio to average only 0.47 km, (n= 8) with the closest nests only 0.25 km apart. Cooper and Cuthrell (2000) found the average distance between nests was 1.5 km (±0.26 km) for state forests in Northern Lower Michigan. In large contiguous areas of suitable habitat in MD and GA the average distance between nests in prime habitat was 0.90 km (range 0.72-1.04 km) and 2.0 km (but two instances where adjacent nests were <1 km apart) respectively (Stewart 1949, Howell & Chapman 1997).

Density or Breeding Density Commonly stated as the number of breeding pairs per unit of area or most often stated as active nests per unit of area, since a more accurate count can usually be made of active nests than of pairs of birds. In high quality Red-shouldered Hawk habitat on the Lakewood District of southern Nicolet National Forest densities of 0.54 nests/km^2 were found (J. Jacobs unpub. data). In other areas of Wisconsin the highest density found for relatively small areas were: central- 1.8 nests/km^2; northeastern- 0.67 nests/km^2.

Dykstra et al. (2000) reported 1.2 pairs/km^2 for SW Ohio, although not representative of their entire study area. McLeod and Andersen (1998) reported 1 nest/km^2 for an area on Chippewa National Forest in north central Minnesota. Crocoll and Parker (1989) for NY, Bosakowski et al. (1992) for NJ, and Stewart (1949) for MD, reported 0.2 nests/km^2, 0.6 nests/km^2, and 0.47 pairs/km^2 respectively.

DEMOGRAPHICS

Breeding system Reported as long term monogamous, probably mates for life, by some early researchers (Bent 1937). Movement by adults to different mates was recorded for a small percent of nest sites in Ohio and Wisconsin (Hays pers. comm., Jacobs and Jacobs unpub. data). Two unusual behaviors published: Ogden (1974) reported a trio (2m, 1f) at a nest in Florida; and, McCrary and Bloom (1984) reported a promiscuous female Red-shouldered Hawk mated with two males during one nesting season in California.

Age structure The age at first breeding is usually 2 years old or older. Sometimes females breed as a yearling (one-year-old bird) with an adult mate. Females were more common as yearling breeders than males (Crocoll 1994, pers. obs.). Only one report of a yearling male/yearling female pair (Apanius 1977). Overall, about 5.3% of the breeding females are yearlings. Wisconsin data varied annually from 0-12% (Jacobs and Jacobs 1999). Other researchers reported 0-10% of female breeders were yearlings (Craighead and Craighead 1956, Henny et al. 1973, Apanius 1977, and Wiley 1975).

The highest percentage (8-12%) of pairs with a yearling breeder occurred the year after a very good reproductive season and no yearling breeders were found the year after a very poor reproductive season (Jacobs and Jacobs 1999). Since it is unlikely that yearlings would displace adults at breeding sites,

yearling female breeders might be an indication of a shortage of adult females in the population, i.e. a higher mortality in adult females than adult males (see mortality).

REPRODUCTION

Proportion of pairs breeding This is a difficult aspect of breeding biology to get data on, especially since Red-shouldered Hawks are so secretive. Only one study attempted to address this issue, Craighead and Craighead (1956), approximately 97% of the total available Red-shouldered Hawk adult breeding population attempted reproduction. In 1942 they monitored 22 pairs, all pairs nested. In 1948, of 18 pairs, 17 pairs nested, approximately 1 pair of 40 did not nest or 2.5%. Each year 2 single, non-paired birds were present. All were immature. There was approximately one non-paired individual for every 10 pairs of breeding birds.

Clutch size Red-shouldered Hawks average about 3.4 eggs per clutch. Clutch size can be an indirect measure of habitat quality, and also an indirect indicator of the physiological condition of reproductively active females (see Pesticides and other Contaminates). Henny (1972) reported clutch size averaged 3.45 (SD .74), for the states of Wisconsin, Michigan, Ohio, Indiana, & Illinois. Craighead and Craighead (1956) found clutch size averaged 3.4 for 40 nests in southeast Michigan. An average clutch size of 3.4 (n=14, range 2-5) was found for central Wisconsin (E. Jacobs unpub. data). The clutch size of Red-shouldered Hawks increased from south to north and from east to west. The smallest average clutch size was reported from Florida (2.36); the largest from the Great Lakes region (3.45), (Henny 1972).

Nest success Red-shouldered Hawks nests average 55% successful for the Great Lakes area over the past 15 years (Table 3). Nest success, success rate, or percent of nests successful, is usually measured as the percent of active nests that produce young to the fledging stage and is commonly reported and compared in raptor studies as a measure of reproductive success (Tables 1-3). The first nine studies in Table 3 compare nest success for Red-shouldered Hawks for the Great Lakes region and show the success rate to average about 55%. While success rate is useful, it is not as important as the number of young produced per active nest.

Productivity Probably the most useful measure of productivity is the number of young fledged per active nest (Tables 1, 2, and 3). An active nest is one in which hawks have laid eggs indicated by an adult incubating in the nest; or, a nest that has green conifer sprigs and one or more white down feathers on it. Often times the number of young per active nests is taken at banding time when the nest tree is climbed and the young in the nest are banded, usually when the young are about 18-30 days old. Comparing productivity (yg/active nest) from various studies sometimes is comparing productivity when young are 20 days old in one study to 30 day old young in another study (Table 3). Dykstra and Hays (pers. comm.) recommend ground checking all nests about 1-2 weeks after mean laying date for signs of activity. Only active nests discovered before young hatch should be used in calculating the number of young/active nest. Young should be at least 21 days old or if chicks are less than 21 days old at banding the researchers should return later to recount chicks.
The number of young fledged per active nest appears to decrease from south to north in the north central states (Table 3). Even in Nicolet National Forest there has been a significant decrease in young per active nest from south to north (J. Jacobs 2000). Nests in Wisconsin south of Nicolet National Forest almost always produce more young per active nest than nests on Nicolet National Forest (Table 1)(Jacobs and Jacobs 1997, 2000).

Another measurement of productivity is the number of young per successful nest. This shows the brood size or how many young the hawks produce in an average successful nest. Besides comparisons with other studies, this information is very useful in calculating population dynamics especially with computer models. Young per successful nest data can be useful to show that the hawks are capable of producing enough young to replace mortality.

Research has shown (Portnoy & Dodge 1979, Penak 1982, J. & E. Jacobs unpub. data) that the brood size declines the longer the young are in the nest. Starvation, predation, disease, competition and weather kill nestlings.

Yg/successful nest is much larger, often one young more per nest, than yg/active nest; and usually there is much less variation in yg/successful nest from nest to nest within a study area, from year to year or between studies, than yg/active nest (Tables 1-3 and Dykstra et al. 2000).

Table 3 compares Wisconsin 2000 reproduction data to studies from other states and to Henny's recruitment rate. Wisconsin has averaged lower reproduction than most other studies. Even the 2000 rate is much lower than other studies. Concern for this low Wisconsin Red-shouldered Hawk reproduction and especially the very low reproduction for Nicolet National Forest (Table 1) has prompted recommendations in previous reports (Jacobs and Jacobs 1995, 1997, 1999, 2000).

Only two of the studies, Stewart's and Bednarz's have exceeded Henny's recruitment rate. Other authors stated that Henny's data was biased and his rates were probably too high (Newton 1979).

A wide variation in reproduction was reported not only between studies but also within the same study, from year to year (Henny et al. 1973, Stravers et al. 1995, and Jacobs and Jacobs 2000) and between areas within the same state (Ebbers 1989, Jacobs and Jacobs 2000). Studies with small sample sizes had the largest ranges.

MORTALITY, SURVIVAL AND RATES OF POPULATION CHANGE

Annual mortality rates are estimated to be approximately 48-58% for the 1st year and 20-25% for adults 2 years and older (based on Henny 1972, Newton 1979, and computer modeling Jacobs and Jacobs unpub. data using Red-shouldered Hawk reproductive data). Band recovery data appears to be the only mortality information available for Red-shouldered Hawks. However, these data (from Henny 1972) are known to be subject to bias (Newton 1979). Table 4 compares life table models generated by a computer population model (PD: Population Dynamics modeling, version 4.0 (c) 1989 by J.W. Grier, Zoology Dept., N.D. State Univ., Fargo, ND) using Henny's information (1972) and data for Wisconsin (Jacobs and Jacobs 2000). Table 5 presents eight possible Red-shouldered Hawk mortality rates for Wisconsin. Striving for a stable population over 50 years, several computer simulations were calculated varying the mortality rates slightly but keeping reproduction constant at 1.1 yg/active nest (the reproductive average found for Wisconsin in the 1990's). Simulations # 5 (50% for 1st year, 22% for adults), although much lower than Henny's estimate, appears to be the most plausible Red-shouldered Hawk mortality rate for Wisconsin. This rate produces a stable or slightly increasing population over 50 years and is within the range of possible mortality rates discussed in Newton (1979). Mortality rates might tend to be higher in Michigan, Ohio and other more southern states because their reproduction rates are higher.

Henny's estimates of mortality and reproduction rates were rejected because: Henny's life table shows the oldest Red-shouldered Hawk would only be 15 years old (Table 4), but Red-shouldered Hawks have been reported to be 20 years old in the wild (see longevity); most breeding studies have lower reproductive rates than Henny's model predicted needed for a sustainable population (Table 3); and, other researchers have rejected Henny's mortality as too high (Newton 1979).

Longevity Maximum recorded age for a wild Red-shouldered Hawk is 20 years (Clapp et al. 1982). Several adults have been retrapped in Wisconsin that are 10-14 years old minimum age, the oldest recorded bird is a 17 year old female (Jacobs and Jacobs 2000).

Reproductive Cycles Productivity for Red-shouldered Hawks varies greatly from year to year (Table 2). Wisconsin Red-shouldered Hawks do not appear to follow a periodic cycle such as the 4-year cycle for Harriers (Hamerstrom 1979) or the 10-year cycle for Northern Goshawks (Erdman et al. 1998). More analysis is needed however, as data from the 1990s shows each high year was followed by two or three low years (Jacobs and Jacobs 2000).

POPULATION STATUS AND VIABILITY

Most national forests in the north central states have surveyed at least some areas for Red-shouldered Hawks. Most are engaged in or planning additional raptor surveys. Red-shouldered Hawks have been reported as breeding birds on all national forests in the north central states except Midewin National Tallgrass Prairie and Superior National Forest. Red-shouldered Hawk populations appear to be relatively stable or suspected decline on the national forests reporting them as breeding birds. Although they can be locally common in prime habitat, they are usually uncommon to rare throughout these national forests. Red-shouldered Hawks are at the northern periphery of their range in the national forests of Minnesota, Wisconsin and Michigan. The following provides a summary of Red-shouldered hawk occurrence for national forests in seven north central states of the Forest Service Eastern Region.

Michigan

Hiawatha National Forest

Four nests have been found and monitored in the past five years with the help of raptor researchers such as Christiansen (1998) and Bowerman. Three quads with Red-shouldered Hawks in Hiawatha National Forest were reported in the Michigan Breeding Bird Atlas (Brewer et al. 1991).

Red-shouldered Hawks are uncommon but widespread. Hiawatha National Forest is at the northern edge of the Red-shouldered Hawk range. The Red-shouldered Hawk population appears stable or possibly increasing, although it is unclear whether birds are moving north from Lower Michigan or local reproduction is causing this increase. It's also uncertain whether Red-shouldered Hawks are recolonizing historic habitat or expanding their range. The long term Red-shouldered Hawk habitat trend is increasing. (Kevin Doran, Forest Biologist and Andi Hales- Hiawatha National Forest, pers. comm. 2001)

Huron-Manistee National Forest

Huron A major decline in the Red-shouldered Hawk population was documented for southern Michigan during the mid – 20th century. The center of the Red-shouldered Hawk population in Michigan now appears to be in the northern part of the lower peninsula (Brewer et al. 1991). The Michigan Breeding Bird Atlas reported Red-shouldered Hawks in 9 blocks on the Huron National Forest (Brewer et al. 1991). Red-shouldered Hawks have been reported for all counties within and adjacent to Huron National Forest (Cooper 1999). Kenn Ennis considered Red-shouldered Hawks uncommon, with a very restricted distribution and a suspected significant decline on Huron-Manistee National Forest in the Regional Forester's Sensitive Species Risk Evaluation. (Kenn Ennis, Forest Biologist-Huron-Manistee National Forest, pers. comm. 2001)

Manistee The Michigan Breeding Bird Atlas reported Red-shouldered Hawks in 30 blocks on the Manistee National Forest. Red-shouldered Hawks have been reported for all counties within and adjacent to Manistee National Forest (Cooper 1999). Ebbers (1989) reported reproductive, habitat parameters, and nest tree data for 8 nests along the Manistee River in Manistee National Forest 1986-1988. The Regional Forester's Sensitive Species Risk Evaluation for Red-shouldered Hawks recommended this species to be listed as sensitive because: it was uncommon on this national forest, had a very restricted population or the majority of its occurrences in state of region on Huron-Manistee National Forest, and it was suspected of significant decline. (Kenn Ennis- Forest Biologist,

Huron-Manistee National Forest, pers. comm. 2001)

Ottawa National Forest

The Red-shouldered Hawk is a rare raptor on Ottawa National Forest, except possibly in the Sylvania Wilderness Area where three pairs (2 nests) have been located (D. Friedrick pers. comm., Andres 1996). Red-shouldered Hawks have been encountered at three other locations over a four-year period, only one old nest has been found. Several thousand acres were surveyed for Red-shouldered Hawks during the summer of 2000, 2001, and 2002, only one positive response. No nest was found. Seven Red-shouldered Hawk locations were reported from the Michigan Breeding Bird Atlas.

The Regional Forester's Sensitive Species Risk Evaluation recommended Red-shouldered Hawks be listed as sensitive because: it was rare, had a localized population, this national forest is at periphery of its range, and the population appears stable but has very limited presence on Ottawa National Forest. (Robert Johnson- District Biologist and Robert Evans- Forest Biologist, Ottawa National Forest, pers. comm. 2001)

Minnesota

Chippewa National Forest

Two historic nest sites were known prior to 1994, one from 1992 and one from 1993. Three active nests were found in 1994 and seven during 1995. Ten other nests were found with defensive Red-shouldered Hawks in the area: two in 1994, and eight in 1995. Eleven probable additional territories were located from road surveys and opportunistic sightings. And at another seven locations, Red-shouldered Hawks responded to one-time surveys. All nests occurred in areas of closed-canopy mature northern hardwoods (17 nests) or mature aspen (3 nests) with interspersed wetlands (McLeod and Andersen 1996).

The Threatened and Endangered Species database shows 36 sites for Red-shouldered Hawks on Chippewa National Forest. Although they are generally widely distributed at low densities throughout this national forest, most of the known sites are concentrated in the Ottertail Peninsula of Leech Lake, Cass County where there is a large area of suitable habitat. Red-shouldered Hawks prefer mature hardwood habitat on Chippewa National Forest. A combination of geology, soil, and logging determines where this habit exists on Chippewa National Forest (J. Casson).

The Regional Forester's Sensitive Species Risk Evaluation listed Red-shouldered Hawks as a sensitive species on Chippewa National Forest for the following reasons: Red-shouldered Hawks are rare, this national forest is outside its principle range, it is rare rangewide, this hawk's distribution is restricted, this national forest is at the periphery of its range, and its population is suspected of significant decline on Chippewa National Forest. This species is sensitive to habitat quality and quantity, and to human disturbance. It needs closer monitoring and habitat management must be defined and tested. It is expected to respond positively to habitat management. It specifically needs riparian, mature forest juxtaposed with lowlands (W. Russ 1999).

The Red-shouldered Hawk is at the very northwestern edge of its range, but apparently is expanding northward and westward in Minnesota (Janssen 1995). The Red-shouldered Hawk was not reported in Minnesota until 1935 and reports have increased during the latter part of the past century suggesting it might have expanded its range northward (Coffin & Pfannmuller 1988). Minnesota has not attempted a Breeding Bird Atlas. (Al Williamson- Forest Ecologist and John Casson- Forest Biologist, Chippewa National Forest, pers. comm. 2001)

Superior National Forest

No breeding Red-shouldered Hawks have been reported from callback surveys or any general sightings from birders. Superior National Forest is northeast of the described range of Red-shouldered Hawks in Minnesota (Coffin and Pfannmuller 1988), so they would not be expected here. Suitable Red-shouldered Hawk habitat might not be present because trees probably have not matured into the type of habitat Red-shouldered Hawks prefer, or perhaps the climate is too cold and the soil not fertile enough. (Edward Lindquist- Forest Biologist, Superior National Forest, pers. comm. 2001)

Wisconsin

Chequamegon-Nicolet National Forest

Chequamegon In the Medford-Park Falls District, Red-shouldered Hawk conspecific callback surveys were made 1997-2000. In some years 150 stops were surveyed, with 18 active territories located. One nest site was found during the Wisconsin Breeding Bird Atlas (Cutright et al. 2001) in the Park Falls Area. In 2001, five historic nest sites have been identified in Taylor County. There is no known reproduction from these nests, two of the five were confirmed to have failed. (Susanne Adams- District Biologist, Medford-Park Falls District, pers. comm. 2001)

In the Washburn District, several Red-shouldered Hawks were seen or heard in the spring of 2000. Wisconsin Breeding Bird Atlas reported one nest on national forest land, and the DNR (Bill Smith pers. comm.) mentioned two areas with Red-shouldered Hawk activity. (Scott Anderson- District Biologist, Washburn District, pers. comm. 2001)

There is little historic data for the Great Divide District. A nest was reported in the Namekagon Lake area from the early 1980's. Two adults and two young were reported from Clam Lake in 1997, and two reports of these hawks in this area from the Wisconsin Breeding Bird Atlas. One Red-shouldered Hawk was seen in 2001. This district might be too far north for Red-shouldered Hawks but there are probably more birds nesting than records show. Three thousand acres were surveyed on foot with conspecific callback tapes, but no responses. (T. Matthiae- District Biologist, Great Divide District, pers. comm. 2001)

Red-shouldered Hawks might be locally common in prime habitat in the southern district (Medford), but widespread and uncommon to rare over most of Chequamegon National Forest. The northern part of this national forest is at the northern periphery of the Red-shouldered Hawk range. The Regional Forester's Sensitive Species Risk Evaluation recommended to add it to the list because: its abundance is rare, its distribution is restricted, this national forest is outside or at the periphery of its principle range, it's rare rangewide, and there is a suspected significant decline on Chequamegon National Forest. . (Norm Weiland-Forest Biologist, Chequamegon-Nicolet National Forest, pers. comm. 2001)

Nicolet Red-shouldered Hawk nests have been monitored by raptor biologists since 1973 (Erdman pers. comm.). Initially only a few nests were found, but 75 historic nest sites have been

identified. This does not represent an increase in population, but reflects an expansion of habitat searched, results from raptor surveys and opportunistic sightings. Approximately 62 sites are foot searched annually, 19 active nests are usually found and monitored for reproductive success and other nesting parameters. Most nests are on the southern district (Lakewood) (J. Jacobs 2000). Red-shouldered Hawks are uncommon on Nicolet. They can be locally common in prime habitat, but most of Nicolet National Forest does not contain nesting Red-shouldered Hawks (J. Jacobs 2000). The Wisconsin Breeding Bird Atlas showed 13 quads with Red-shouldered Hawks (Cutright et al. 2001).

Red-shouldered Hawk conspecific call-back surveys were conducted during 1992-94 at 945 predetermined stations. Red-shouldered Hawks responded at 109 of them. Two hundred and ten pairs of Red-shouldered Hawks were calculated to be in the areas surveyed and a maximum of 250 pairs of Red-shouldered Hawks was estimated for all of Nicolet National Forest (Erdman and Jacobs 1994).

A *Viable Population Planning Worksheet* (Rinaldi et al. 1990), stated that the primary habitat requirements for reproduction was unfragmented, mature, mixed conifer and hardwood forests with riparian areas (hemlock, beech and yellow birch are important tree species). Foraging habitat was mostly riparian, conifer swamps and wetlands. The southern district (Lakewood) had fairly good availability of primary habitats, whereas the northern districts were moderate. The expectation was a stable breeding population, possibly decreasing due to mammal predation (fisher). Suspected reasons for breeding population to decline included: cutting of mature hardwoods forest, destruction of riparian forests, more forest fragmentation, and change of natural forests to industrial forests of aspen regeneration and pine plantation.

Low reproduction and nest fidelity on Nicolet has been a concern. Reproduction decreased from an average of 1.53 yg/active nest (n=32) 1973-1986 to .53 yg/active nest (n=62) 1986-1990 (Rinaldi et al. 1990). Reproduction averaged only .76 yg/active nest (n=196) for the 11 year period 1991-2001 (J. Jacobs 2001). Reproduction was lower on the northern two-thirds of this national forest than on the southern one-third, possibly because this northern part of the forest is the northern periphery of the Red-shouldered Hawk range. Nicolet National Forest has lower reproduction than two other areas surveyed in Wisconsin (Table 1, Jacobs and Jacobs 2000), and much lower than other studies (Table 3). Low reproduction has been attributed to the dramatic rise in the fisher population since 1985 (J. Jacobs 2001). Reproduction is below the sustainable rate predicted in the model discussed earlier in Mortality.

To evaluate the low long term productivity on the Nicolet National Forest, a portion of the 1992-1994 callback survey was repeated in 1999 (J. Jacobs 1999). Since similar results were found in both surveys the author concluded that either birds moved north from the adjacent Menominee Indian Reservation or Nicolet populations are remaining stable despite low reproduction rates. (Norm Weiland-Forest Biologist, Chequamegon-Nicolet National Forest, pers. comm. 2001)

ILLINOIS

Shawnee National Forest

There is limited data for Red-shouldered Hawks on Shawnee, but they were reported from 9 Shawnee quads on the Illinois Breeding Bird Atlas (Kleen 1998). Although this species is endangered in Illinois, it is a relatively common breeding raptor in the southern tip of the state. Raptor Callback

Surveys in 1990, by the Illinois Natural History Survey found them in Pope and Union counties (Malmborg and Vanderah 1991). Red-shouldered Hawks are not listed as a Regional Forester's Sensitive Species. (Michael Spanel- Forest Biologist, Shawnee National Forest, pers. comm. 2001)

Midewin National Tallgrass Prairie

The Red-shouldered Hawk is not a nesting bird, probably because of lack of suitable habitat. There were no responses to raptor callback surveys done in 1993 and later. Several quads of the Illinois Breeding Bird Atlas northeast and west of Midewin had Red-shouldered Hawks. (William Glass- Forest Biologist, Midewin National Tallgrass Prairie, pers. comm. 2001)

Indiana

Hoosier National Forest

In 1990, Allen Parker completed a raptor callback survey using the call of a Great Horned Owl. Red-shouldered Hawks were the most frequently detected raptor. Gross estimates of population density were 0.17-0.22 pairs/km^2 (min-max), approximately 129-167 pairs on Hoosier National Forest. A repeat of this survey is planned for 2002 using the same plots and transects setup by Parker.

A breeding bird survey has been done for breeding seasons: 1991-93 (16 Red-shouldered Hawks recorded), 1995 (3 Red-shouldered Hawks recorded), 2000 (15 Red-shouldered Hawks recorded), and 2001 (8 Red-shouldered Hawks recorded). Purdue University is summarizing the breeding bird survey data.

The 1999 Regional Forester's Sensitive Species Risk Evaluation recommended not adding Red-shouldered Hawks to the list. Its abundance is rated as uncommon on Hoosier and not common when compared with other species. Southern Indiana has the largest population of Red-shouldered Hawks in the state. More than 20 Red-shouldered Hawks have been observed on Hoosier National Forest (1980s and 1990s DNP). It was the most common woodland raptor detected on Hoosier National Forest (Parker 1990). Its distribution was widespread and Hoosier National Forest is well within the range of this species. Its population trend appears stable, increasing or within natural population fluctuations on Hoosier. Its population is probably stable on this national forest, but declining in other locations. Its habitat needs have been identified as mature forests with dense canopy cover near water.

The Indiana Heritage databases shows 29 records of Red-shouldered Hawks from 1983-1993. The Indiana Breeding Bird Atlas (Castrale et al., 1998) showed most Red-shouldered Hawks in the southern one-third of the state with approximately 20 blocks from Hoosier National Forest reporting them. (Kelle Reynolds- Forest Biologist, Hoosier National Forest, pers. comm. 2001)

Missouri

Mark Twain National Forest

In the1986 Mark Twain National Forest Plan the Red-shouldered Hawk was listed as rare, present in small numbers in Missouri. It is a locally common permanent resident to the Mark Twain area. The Missouri Breeding Bird Atlas (Jacobs and Wilson 1997) showed Red-shouldered Hawks

present in at least 34 quads of Mark Twain National Forest. This species is not on Mark Twain's Regional Forester's Sensitive Species list. (Mary Lane- Forest Biologist, Mark Twain National Forest, pers. comm. 2001)

Ohio

Wayne National Forest

Forest-wide point counts were conducted in mature hardwood habitat, 720 points annually for 1992-94. Red-shouldered Hawks were detected at 17, 7, and 5 points per year respectively. If a Red-shouldered Hawk could be heard for an average of 200 yards, an estimate of approximately 1 Red-shouldered Hawk/3 sq.mi. could be made from the data, the number would be higher in prime riparian habitat.

Nest surveys were conducted on the Ironton District in 1999 & 2000. Suitable habitat throughout the district was searched, concentrating on hardwood forests along the major streams. No set routes were followed. Callback tapes were used when suspected Red-shouldered Hawk nests were located. In 1999, 13 Red-shouldered Hawk nests were found and monitored. In 2000, 8 nests were found, but not monitored. Approximately 1,100 miles of roads were driven. A density of 1 pair/6 sq.mi. was estimated.

Presence/absence surveys were conducted for Ironton District on 3823 acres of grassy/brushy, wetland and early succession habitat in 2000. The objective was to identify the bird species using this habitat (not prime habitat for Red-shouldered Hawks). Ten Red-shouldered Hawks were found almost all around the edges of the survey areas, or flying overhead.

Presence/absence surveys were conducted on Ironton District on 1,792 acres of pine of various species and ages in 2001. The primary objective was to locate pine warblers, but all other species detected were recorded. Seven Red-shouldered Hawks were found. An estimated population of 1.5-2 /sq.mi. could possibly be inferred.

The amount of suitable Red-shouldered Hawk habitat available on the Ironton District is typical of the entire Wayne National Forest. From all data above an estimate of .33-2 Red-shouldered Hawks/sq.mi. could possibly be made for the entire forest. Wayne National Forest has 233,000 acres or 364 sq.mi., this would equate to an approximate estimated population of 60-360 pairs of Red-shouldered Hawks.

The 1999 Regional Forester's Sensitive Species Risk Evaluation for Red-shouldered Hawks rated their abundance as uncommon on Wayne National Forest. Their distribution is restricted to localized habitat. Their population trend appears stable, increasing or within natural population fluctuations on this national forest. Evaluation warrants this species to be removed from list. The Ohio Breeding Bird Atlas (Peterjohn & Rice 1991) showed Red-shouldered Hawks present in at least 18 blocks or other observations on Wayne National Forest.
(Kathy Flegel- Forest Biologist, Wayne National Forest, pers. comm. 2001)

POTENTIAL THREATS

Habitat Alteration (Present or Potential Risks to Habitat or Range)

Breeding habitat alteration appears to have been and probably continues to be the greatest threat to viable Red-shouldered Hawk populations. Many Red-shouldered Hawk researchers have identified or implied habitat alteration (cutting preferred habitat) as the probable cause for their population

decline (Butler 1898, Craighead and Craighead 1956, Brown 1971, Bednarz and Dinsmore 1981, Bryant 1986, Woodrey 1986, Hands et al. 1989, Castrale 1991, Peterson & Crocoll 1992, Peterson et al. 1992, Crocoll 1994, Webster and Chamberlain 1995, Castrale et al. 1998, Kleen 1998). Because Red-shouldered Hawks utilize extensive, contiguous, mature (large pole or sawtimber size or old growth-like), wet, hardwood forests, any logging of this habitat is a potential threat. Management that significantly decreases this habitat will likely have a negative effect on Red-shouldered Hawk populations.

Selective harvesting of hardwoods, if done properly, can be compatible with Red-shouldered Hawks. Timber harvesting frequency, method, extent, time of year, and type of habitat, are some of the factors that determine the effect on the Red-shouldered Hawk population. Management practices such as: clear cutting; selective logging that does not maintain a closed canopy forest with large hardwood trees; ditching; draining; and, cutting wetland forests, all destroy preferred habitat. Management practices that increase Red-shouldered Hawk preferred habitat would likely have a positive effect on their populations.

Disturbance (Commercial, Recreational Over-utilization) The highest sensitivity to disturbance is during nest building and incubation periods. The longer these hawks are into the nesting period, the less likely they are to abandon the nest. Tree marking, camping, logging, road building, scientific studies, etc., are activities that put people in Red-shouldered Hawk habitat in early spring before "leaf-out" which could disturb nesting hawks and cause desertion of nests. Nests with young are tolerant to minor human disturbances. Although they are generally secretive hawks, they are very tolerant to disturbances during the non-breeding season.

Predation, Competition, Siblicide/Cannibalism, Disease and Parasites

Predation can be locally heavy on nesting adults, young and eggs. Adults are killed by other larger birds of prey including: Golden Eagle (*Aquila chrysaetos*), Red-tailed Hawk, Great Horned Owl, Peregrine Falcon (*Falco peregrinus*)(from Palmer 1988, Crocoll 1994), and Northern Goshawks (*Accipter gentilis*)(in Michigan, Postupalsky pers. comm.). During 32 years of research on nesting Northern Goshawks in Wisconsin, Erdman has not found Red-shouldered Hawks as prey items even though they sometimes nest within 200m of a Northern Goshawk nest (pers. comm. Adults, young and eggs have been killed by Great Horned Owls (Crocoll and Parker 1989), Fisher (*Martes pennanti*) and Marten (*Martes americana*)(J. Jacobs unpub. data). Raccoons (*Procyon lotor*) are suspected to be the most common predators on eggs and young (Crocoll 1994, J. Jacobs unpub. data). Black Bear (*Ursus americanus*) are suspect for the loss of young at two nests on Nicolet National Forest (J. Jacobs unpub. data). Porcupine (*Erethizon dorsatum),* Bobcat (Felis rufus), Opossum (*Didelphis virginiana*), Gray Fox (*Urocyon cinereoargenteus),* Common Raven (*Corvus corax*), and American Crow (*Corvus brachyrhynchos*) probably also destroy eggs or take young, but no evidence was found from field research, nor literature search. Raccoon, Great Horned Owl, and Fisher are believed responsible for the majority of nest failures in Wisconsin (Jacobs and Jacobs 1997). Predators will often remove one or two young and leave the rest in the nest (J. & E. Jacobs pers. obs.). Adult females suffer higher mortality at nests than adult males in NE Wisconsin (J. Jacobs pers. obs.).

Competition Any animal that eats the same food as a Red-shouldered Hawk is a competitor. Northern Goshawks, Red-tailed, Broad-winged, and Cooper's Hawks, Barred and Great Horned Owls

all eat some of the same prey as Red-shouldered Hawks. Even small to medium sized mammals such as mustelids and Raccoons eat some of the same prey as Red-shouldered Hawks. (Rusch and Doerr 1972, Bednarz and Dinsmore 1981). Red-tailed hawks are the closest competitor, but only where the preferred habitat has been altered (Bednarz and Dinsmore 1981, 1982, Bryant 1986, J. & E. Jacobs pers. obs.). These raptors differ sufficiently in habitat preferences, body size, hunting behavior, preferred prey sizes and types, and nesting phenology that interspecific competition should not severely limit Red-shouldered Hawk populations under natural conditions. However, a younger and more fragmented forest has favored many of these raptors at the expense of Red-shouldered Hawks (Bryant 1986).

Siblicide/Cannibalism Not reported in literature. In Wisconsin, young in the nest, less than 16 days old, have been observed pecking other young hard on the head, but no observed siblicide (J. & E. Jacobs pers. obs.). One or two young in most nests disappear before they fledge because of predation, disease, parasites, weather, starvation-competition, pushed or fall out of nest, or possibly siblicide (Penak 1982, Portnoy and Dodge 1979, J. & E. Jacobs pers. obs.).

Disease and Parasites (mostly from Crocoll 1994) Fledglings were reported with permanent blindness caused by developmental ocular lesions (Buyukmihci et al. 1988). One blood parasite (*Leucocytozoa sp*.) has been reported (Kocan et al. 1977) and four external parasites: two louse species (*Colpoephalum flavescens, Philopterus taurocephalus*), a bird fly (*Lynchia americana*)(Peters 1936), and the parasitic larvae of the fly *Protocalliphora sp*. (Sargent 1938). This larva infests the ears and base of wing feather follicles of nestlings. In Wisconsin, almost every nestling examined, older than 25 days, has had these blood-sucking maggots in their ears, and several have had them wedged at the base of wing feathers. They apparently drop off before the nestling fledges and pupate in the bottom of the nest, with little apparent damage to the hawks.

Pesticides and other Contaminants (mostly from Castrale 1991, Crocoll 1994)

Several toxic chemicals and insecticides have been found in Red-shouldered Hawk tissues and eggs: DDE, DDD, DDT, dieldrin, heptachlor epoxide, hexochlorobenzine, mercury, chlordane, dieldrin, Furadan 10, and organochlorine and polychlorinated biphenyls (Havera and Duzan 1986, Hands et al. 1989). Eggshell thinning was recorded from populations during the early 1970's: in Maryland 9% thinning (Henny et al. 1973); 14% in California (Wiley 1975); and, 12% in Ontario (Campbell 1975). Thinning was not as great as reported in several other raptors, and the effect of eggshell thinning on reproductive performance remains inconclusive (Henny et al. 1973, Wiley 1975). Adults have died from a combination of chlordane, heptachlorepoxide, and dieldrin (Blus et al. 1983) and Furadan 10 (Balcomb 1983**)**.

Other Natural or Human Factors Affecting Continued Existence of Species

Major insect pests like Gypsy Moths (*Porthetria dispar*) and Northern or Forest Tent Caterpillars (*Malacosoma disstria*) etc., that can defoliate and/or kill forest trees over a large area might affect reproduction or cause temporary or long term loss of Red-shouldered Hawk habitat. For example, extensive defoliation in Nicolet National Forest by Forest Tent Caterpillars during May and June 1989 apparently exposed nestling Red-shouldered Hawks to heavy predation by fisher, raccoons, and Great Horned Owls, only one young Red-shouldered Hawk fledged from 19 active nests (.05 yg/active nest). This is the worst reproductive success recorded for Wisconsin during 30 years of research (J. & E. Jacobs unpub. data).

Loss of major prey species, such as the recent decline in frogs (Lannoo 1998), might already be affecting Red-shouldered Hawk breeding populations.

It is impossible to predict how some natural factors will affect Red-shouldered Hawk populations. Extreme weather like late spring snowfalls, wind storms, drought, etc., can have direct or indirect negative effects on annual Red-shouldered Hawk reproduction. The effects of something like global warming are unknown. West Nile Virus might kill large numbers of birds including Red-shouldered Hawks.

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES AND HABITAT PROTECTION

National forests analyze the impacts of all projects, including timber sales, on R9 Sensitive Species that are present. Ottawa and many other national forests do conspecific callback surveys and a biologist visits the site prior to writing the Environmental Assessment, Biological Evaluation (BE), and project implementation. During the BE, each project alternative is evaluated for its potential impacts on all R9 Sensitive Species, including Red-shouldered Hawks. Therefore, impacts to Red-shouldered Hawk habitat on each project are considered. Projects that might cause adverse impacts to habitat are redesigned or mitigation measures are used to reduce or eliminate the impact.

National forests of Michigan, Minnesota and Wisconsin have general guidelines for Northern Goshawks and usually use these guidelines when a Red-shouldered Hawk nest is encountered. Three examples of Forest Service management guidelines are given in this section, please see appendix for several more lengthy guidelines.

Michigan

Hiawatha National Forest

Red-shouldered Hawk habitat, nest trees and range size as described in the literature (Postupalsky 1980, Hands, et al., 1989) are considered in the environmental assessment and biological evaluation of timber sale projects. Habitat suitability requirements for Red-shouldered Hawks parallel those of Northern Goshawk. Both species primarily nest in open understory, mature hardwood stands with a closed canopy. Like Northern Goshawk, Red-shouldered Hawks also prefer secluded areas where their nests will not be disturbed. For these reasons, rationale and effects as written for Northern Goshawk also apply to Red-shouldered Hawks. Guidelines are similar to Chequamegon-Nicolet. (Kevin Doran, Forest Biologist, and Andi Hales- Hiawatha National Forest, pers. comm. 2001)

Huron-Manistee National Forest

A 37-page strategy for Northern Goshawks was developed in 1993 and has been in use since then. These guidelines are also used for Red-shouldered Hawks. Guidelines are similar to, but more extensive than other national forests, and too extensive to reproduce in this document. See below and appendix for similar guidelines. (Kenn Ennis- Forest Biologist, Ottawa National Forest, pers. comm. 2001)

Ottawa National Forest

No formal standards or guidelines in Forest Plan for the Ottawa for Red-shouldered Hawks or Northern Goshawks, but Northern Goshawk management guidelines written in 1995 are generally applied when a Northern Goshawk or Red-shouldered Hawk nest is encountered in or near a project area. A standard in the Forest Plan requires the maintenance of at least 240,000 acres of pole-sized to mature northern hardwood forest for species such as Northern Goshawks and Red-shouldered Hawks. The amount of mid-aged to older-aged forest on the Ottawa greatly exceeds the 240,000 acres because of additional areas designated wilderness, the wild/scenic river corridors, semi-primitive and other areas. Adding all that together, at least half of Ottawa National Forest (500,000 acres out of one million acres) is now or will soon be mature forest habitat. As these forests continue to mature, suitable Red-shouldered Hawk habitat will increase.
(Robert Evans- Forest Biologist, Ottawa National Forest, pers. comm. 2001)

Ottawa national forest biologists consensus guidelines for northern goshawk management on the ottawa national. Forest 11/6/95
[also used for red-shouldered hawk management]

General Nest Site Guidelines

Northern Goshawks nest in extensive stands of hardwoods and mixed hardwood/conifers. The latter may be superior habitat because of the availability conifers particularly for daytime cover from mobbing birds. While Northern Goshawks have been reported to nest in areas that have "---high tree canopy and a high density of large trees", many Northern Goshawk nest trees on the Ottawa are found in medium to large sized aspen trees. Nest tree species are variable; however, yellow birch, maple, and even conifers are used. The key seems to be a stable platform (first major crotch, frequently 40-50 feet up in a 70-100 foot tree) with a significant protective canopy over the nest. When undisturbed, Northern Goshawks are very loyal to the nest site, some trees being used for decades. The understory is somewhat open around the nest tree (not brushy). This open understory characteristic may be related to the accessibility of prey to the Northern Goshawk (as it is to the prey of barred owls). Northern Goshawks are usually VERY aggressive in defense of the nest and will attack people who venture near an active nest during the nesting season. On the other hand, severe nest site disturbance, such as road building or timber harvest activity can cause abandonment of nests, particularly during incubation of the eggs. Timber harvest activity that occurs during the non-nesting season when the birds are not really attached to the site (although Northern Goshawks are year-round residents) seems to not cause abandonment if the site is not severely changed such as by clearcut. Indeed, vegetation management that tends to increase growth of the remaining trees, such as thinning or selection harvest, particularly with relatively closed canopies over most of the area which promotes the open characteristic described above, may enhance Northern Goshawk habitat.
Given the above considerations, and considering that each site manager should be allowed considerable discretion in implementing these guidelines. The following general nest site guides are suggested:

(1) The area around the nest, minimum size 30 acres, is managed to maintain a relatively closed canopy and no cutting will be permitted during the period March 1- Sept.1. Where the size of the

stand incorporation the nest equals or exceeds 30 acres, the whole stand will generally be protected. However, particularly large stands may need to be subdivided.

(2) No new roads or trails will be built and no vegetation management will occur within 300 feet of the nest tree itself. Consideration will be given to closing or rerouting roads or trails that are found within 300 feet of a nest, depending upon use patterns on the road or trail, i.e., whether or not it will get much use during the nesting season. If the nest tree is located within a stand, but less than 300 feet from the boundary, the boundary will be moved such that the nest tree is 300 feet or more from it. This will be done on paper and, if necessary, in the field (during marking of a stand, etc.).

(3) Impacts on known Northern Goshawk nests will be analyzed during the IRM process.

(4) Human disturbance will be minimized, including monitoring efforts, at known nest sites during the nesting season.

(5) During the non-breeding season, or during banding of fledglings, known nest trees will be protected from predators (particularly fisher which have been reported to be responsible for most, if not all, Northern Goshawk productivity loss in Wisconsin) by placing greased metal baffles (1 meter tall) around nest trees.

GUIDELINES ON LOCATING AND REPORTING NORTHERN GOSHAWK NESTS

Northern Goshawk nests on the Ottawa average about 18" and are usually in yellow birch, or aspen, or white birch. The apparent preference for poplars on the Ottawa is probably related to the fact that in the far north where Northern Goshawks are most abundant, aspen and birch are the only hardwoods available. Unlike eagles, white pine does NOT seem to be preferred. However, the presence of nearby hemlock or other conifers for cover is considered a plus. Aspen frequently develop a crotch at about 45 feet and that is where the nest is located.

Nests are large 14"-36" wide and 12"-20" deep. If nests are encountered during the nesting season (hopefully, if you are standing under an active nest, you are either legally banding the young or it is an accident). Three things will alert you to Northern Goshawk activity: (1) fresh whitewash near the base of the tree; (2) feathers sticking to branches in and around the nest (binoculars); and, (3) fresh sticks in the nest. If there are eggs or young in the nest and you somehow got near it without being dive bombed, it would be a good idea to tighten the chin strap on your hardhat. Northern Goshawks have been known to actual knock peoples' hats off if they got near the nest. It is also a good idea to learn what Northern Goshawks sound like. While their "Kuk-Kuk" call is distinctive, they occasionally give out a somewhat plaintive "E-you" similar to the end of a Red-shouldered Hawk call. If in doubt, have a biologist play their tapes for you.

It is extremely important in the early stages of egg development that the birds are not kept off the nest if weather is cold or rainy. Visitations to the nest, even for monitoring, should be brief. During the non-nesting season or during banding of fledglings, and in isolated areas where it would not draw the attention of humans, placing a greased 1 meter metal flashing around the tree may help prevent predation of the eggs or young by raccoons, or even adults in case of fisher. Northern Goshawks will utilize the same nest for several years, or will build a new nest within the same general area. Also, they may return to an old nest after not using it for several years.

In the area around the nest, a plentiful supply of prey is essential. However, since Northern Goshawks eat a wide range of prey from robins, to red squirrels, to snowshoe hare, the habitat needed to provide appropriate prey base is highly varied. Early stages of aspen stands probably produce additional snowshoe hare. However, they also provide good cover for snowshoe hares.

Certainly very large stands of young aspen or other brushy situations with numerous edges and open hardwood stands with occasional brushy areas interspersed are probably ideal.

All people who work in the woods should be aware of (1) what Northern Goshawks look and sound like (2) what Northern Goshawk nests look like and (3) to whom incidental sightings should be reported. If you are attacked by a Northern Goshawk, you are almost certainly VERY close to the nest. Remember, It is important to NOT make the location of the nest known if you think there is a possibility of poachers finding the nests. Northern Goshawk fledglings have been reported to be worth over one thousand dollars each on the black market. They cannot be legally taken from the wild in Michigan.

Finally, what do we do when we find a Northern Goshawk nest after we have a project already underway? Contact the district biologist and seek advice. Also make sure other resources specialists that may be affected also are informed, such as the timber management staff. There are provisions in timber sale contracts to handle these contingencies and operators are generally cooperative concerning these matters. Simply postponing a cutting period or making a small adjustment on the sale may be in order. Adjustments to sold sales must be at the mutual agreement of the forest service and the buyer. Have faith. Most people want to help, and your district biologist is responsible for monitoring these animals and making recommendations for their protection.

MONITORING

(1) Random (general) Surveys- These surveys will be conducted annually as an overall index of Northern Goshawks and as an attempt to find nests before projects take place or are proposed. Each district will have one or more of these routes which will be identified on maps; and records will be kept at each district and in a Forest Level database:

a. Routes generally will be six kilometers in length with one station per 300 meters. Taped calls of adult Northern Goshawks will be played (alarm) during the nesting period (March 20-May 6). Most general surveys will be conducted at this time. If surveys are conducted later in the year, a juvenile begging call will be used.

b. Calls will be repeated three times at each station and the number, direction of approach, and species of all responding raptors recorded.

(2) Project Surveys- These surveys will be conducted on foot or ATV and will require choosing a route covering any potential habitat disturbing project such as vegetation management, land exchange, or road construction. Route length will vary depending on the extent of the project, but sampling intervals will be the same as general surveys above (station every 300 meters).

(3) Known Territory Monitoring- Some monitoring of known territories will be conducted as with eagles/osprey/loon to gather additional management information such as productivity, nest fidelity, and potential nest site disturbances. Sampling intensity will be at the discretion of the district biologist and will be particularly sensitive to actual disturbance of the nest caused by monitoring per se. Confidentiality of nests is essential to protect them from poaching, a serious problem for Northern Goshawks. Callback tapes will NOT be used to monitor known nest sites. Merely walking near a site is usually enough to get a response at close range. Disturbance of incubating pairs is a concern.

Recommended by Ottawa National Forest Biologist Nov. 6, 1995

Paul Busch Karen Nash Jerry Edde
Robert Evans Colleen Matula Robert Johnson

Michigan Department of Natural Resources, Wildlife Division developed Management Guidelines for Red-shouldered Hawks on state owned lands (Appendix 1). Several Michigan national forest wildlife biologists participated in the Woodland Raptor Working Group that developed these management guidelines. These guidelines are being tested by Michigan Forest Managers before final endorsement.

Minnesota

Chippewa National Forest

No general standards or guidelines for Red-shouldered Hawks are in the forest plan. Each project area is evaluated on an individual basis after a conspecific callback survey has been completed to detect breeding Red-shouldered Hawks. Red-shouldered Hawk literature is reviewed and specific recommendations are made for each project area. (Al Williamson- Forest Ecologist and John Casson- Forest Biologist, Chippewa National Forest, pers. comm. 2001)

Superior National Forest

No standards or guidelines for Red-shouldered Hawks are in the forest plan, because no Red-shouldered Hawks have been reported on Superior National Forest nor have any nests been found. Some timber stands appear to be just now maturing (from the logging and burning, and subsequent planting back in the 1910-1940's) into stands with suitable structures for Northern Goshawks and possibly Red-shouldered Hawks. (Edward Lindquist- Forest Biologist, Superior National Forest, pers. comm. 2001)

Minnesota DNR is surveying to assess distribution of Red-shouldered Hawks, and developing management guidelines.

Wisconsin

Chequamegon-Nicolet National Forest

Chequamegon has been using the habitat protection stated below for the past few years. Nicolet has had guidelines in place since 1986. Most of these guidelines attempt to protect the habitat immediately around a known active nest. (Norm Weiland- Forest Biologist, Chequamegon-Nicolet National Forest, pers. comm. 2001)

Existing Standards and Guidelines for Red-shouldered Hawks Nicolet National Forest 1986 pg. 63-64 Land and Resource Management Plan

Within known territories the following protection guides will be adhered to:

1. Incorporate nest sites into a stand with a minimum size of 20 acres to be designated old growth. (Some territories will need to be larger to retain their productivity.)

2. Stands immediately adjacent (within a minimum of 300 feet) to the designated territory (old growth stand) will not be clearcut if practical silvicultural alternatives are available.
3. Generally, no new roads will be built or existing ones reconstructed within the designated territory (old growth stands), or within 300 feet of nests. Existing roads will be closed where possible. Where roads are built, seasonal restrictions will be imposed on their use.
4. Human disturbance, to the extent possible, will be eliminated or reduced between February 1st and August 1st, (the most critical nesting period being April 1st to May 15th).
5. The effects on raptor territories will be analyzed through the Integrated Resource Management implementation process.

DRAFT FORESTWIDE STANDARDS AND GUIDELINES
from Chequamegon National Forest March 2001 pg. 26

Northern Goshawk and Red-shouldered Hawk

Standards:

- Identify territories or stands for active and historic nest sites with a minimum size of 20 acres. This area may be larger to retain territory productivity and to include adjacent historic territories in high quality habitat. All land use activities will be excluded except those necessary to protect active and/or historic nest sites for as long as the stand is suitable habitat.
- Do not clearcut adjacent stands within a minimum of 300 feet of the designated territory.
- Forest Service roads and trails within 300 feet of a nest site will normally be closed to vehicular traffic or relocated from February 15 to August 1. This requirement may be waived if no feasible alternatives exist and use can be justified.

Guidelines:

- Within high quality northern Goshawk or Red-shouldered hawk habitat (determined by a wildlife biologist), silvicultural practices will emphasize higher residual basal areas and smaller size and number of canopy gaps (compared to normal practices).
- Conduct surveys for these hawk species prior to projects being implemented within potential habitat areas.
- Maintain, protect, and enlarge areas of mature hardwood/hemlock/white pine forest with an emphasis on low fragmentation and contiguous canopy cover (minimum 80% canopy cover).
- Minimize human disturbance within the designated territory between February 15 and August 1.

The Wisconsin DNR is in the beginning stages of creating guidelines for woodland raptors. Currently, guidelines exist for Bald Eagles and Osprey.

Illinois
Shawnee National Forest

Current guidelines for Red-shouldered Hawks are generic. “Maintenance of large extensive contiguous tracts of mature bottomland forest will insure that viable populations of this species are maintained within the planning area.” (Michael Spanel- Forest Biologist, Shawnee National Forest, pers. comm. 2001)

Midewin National Tallgrass Prairie

No specific management guidelines, but general standards under Heron and Raptor Nest Protection Standards.

1. Provide for the protection of raptor (hawk or owl) nesting habitat and great blue heron rookeries.
2. Conduct project level inventories to identify heron rookeries and raptor nesting habitat using the most recent inventory protocols.
3. Protect active rookeries and raptor nesting habitat. Active nests will be protected with a no activity buffer of 900-foot width for tree nesting birds and 1,300 feet for ground nesting raptors. Prevent disturbance in this buffer area during the active nesting season (generally March 1 through August 15).

(William Glass- Forest Biologist, Midewin National Tallgrass Prairie, pers. comm. 2001)

INDIANA

Hoosier National Forest

No specific management guidelines for this species.
(Kelle Reynolds- Forest Biologist, Hoosier National Forest, pers. comm. 2001)

Missouri

Mark Twain National Forest

In the 1986 Mark Twain National Forest Plan the Red-shouldered Hawk is listed as a species of concern. Forest-wide direction states ‘When Species of Concern or their habitat are encountered, projects will be modified as necessary to ensure the continued existence of the species as a viable population. If it is determined that management practices jeopardize the survival of a Species of Concern as a viable population, that species will be evaluated for nomination as a Regional Sensitive Species under Regional Forester authority. As of January 1986 there are no Regional Sensitive Species identified.’ P.IV-50□1 (Mary Lane- Forest Biologist, Mark Twain National Forest, pers. comm. 2001)

Ohio

Wayne National Forest

Wayne National Forest does not maintain a forest species of concern list. The Forest Plan does not include provisions directed at the Red-shouldered Hawk, other than standards and

guidelines that protect and enhance wildlife habitat and forest diversity in general. (Kathy Flegel-Forest Biologist, Wayne National Forest, pers. comm. 2001)

Inadequacy of Existing Regulatory Mechanisms

Red-shouldered Hawks have no Federal status. They are a conservation priority for Region 3, U.S. Fish and Wildlife Service. They are listed as state endangered, threatened, species of special concern, or no state status in the states covered by this document. This status often makes managers and landowners aware of the Red-shouldered Hawk and encourages considerations for its habitat, but usually does not demand habitat protection or mitigation. Red-shouldered Hawks are too common nationally to warrant federal endangered or threatened species listing.

MONITORING AND RESEARCH

Existing Surveys Standard bird surveys have been done at most national forests in the north central states. (See Appendix 2 for description of surveys) The most common bird surveys are: Breeding Bird Census (BBC), North American Breeding Bird Survey (BBS), state Breeding Bird Atlases (BBA), university research projects or contract research projects, and the Christmas Bird Count for wintering birds. While these surveys can be useful for determining distribution and population trends of some species of readily visible raptors, they provide only limited information on woodland raptors (Iverson and Fuller 1991). Specific raptor surveys and research are needed to determine status and viability for Red-shouldered Hawks.

Michigan

Hiawatha National Forest

Hiawatha National Forest currently has a long-term woodland raptor project headed by William Bowerman. Although focusing on the Northern Goshawk, other raptors are documented when encountered and nest searches conducted. Red-shouldered Hawks are a concern and nests are monitored when located. Four nests have been found and monitored in the past five years.

Christiansen (1998, in a cooperative study with Bowerman) reported on three hawk species, Red-shouldered Hawks, Northern Goshawks, and Red-tailed Hawks in the Upper Peninsula of Michigan including the East and West Units of Hiawatha National Forest for 1996-97. Characteristics of 7 Red-shouldered Hawk, 27 Red-tailed Hawk and 20 Northern Goshawk nests were compared with those from 118 random plots. One Red-shouldered Hawk nest was reported from the West Unit.

Three quads with Red-shouldered Hawks in Hiawatha National Forest were reported in the Michigan Breeding Bird Atlas (Brewer et al. 1991). (Kevin Doran, Forest Biologist, and Andi Hales-Hiawatha National Forest, pers. comm. 2001)

Huron-Manistee National Forest

Huron The Michigan Breeding Bird Atlas reported Red-shouldered Hawks in 9 blocks on Huron National Forest (Brewer et al. 1991). Red-shouldered Hawks have been reported for all counties within and adjacent to Huron National Forest (Cooper 1999). (Kenn Ennis- Forest Biologist, Huron-Manistee National Forest, pers. comm. 2001)

Manistee The Michigan Breeding Bird Atlas reported Red-shouldered Hawks in 30 blocks on the Manistee National Forest. Red-shouldered Hawks have been reported for all counties within and adjacent to Manistee National Forest (Cooper 1999).
Ebbers (1989) reported reproductive, habitat parameters, and nest tree data for 8 nests along the Manistee River in Manistee National Forest 1986-1988. (Kenn Ennis- Forest Biologist, Huron-Manistee National Forest, pers. comm. 2001)

Ottawa National Forest

Red-shouldered Hawks have been encountered at three locations. One Red-shouldered Hawk responded during nesting season surveys of several thousand acres (Kenton District) in 2000, an old nest was found in that area in the winter 2000-01. Two other encounters, one by Golden Lake in Iron River District in the summer of 1996. Another Red-shouldered Hawk was heard in the fall of 1999 on the Ontonagon District. No nest was found.
(Joanne Thurber-Kenton District, Brian Bogaczyk-Bessemer District)

Several researchers have worked on Ottawa, including: Bill Bowerman et al. ongoing research on woodland raptors, Sergij Postuplsky's research on Michigan raptors (1980), and Sue Andres and Bob Howe independently on breeding bird surveys. Three pairs of Red-shouldered Hawks were found in the Sylvania Wilderness Area, one active nest was located in 1993 by Bob Howe's nesting bird survey group (Denise Friedrick pers. comm.), and one in 1994/95 by Sue Andres (1996). Seven Red-shouldered Hawk locations were reported in the Michigan Breeding Bird Atlas. (Robert Evans- Forest Biologist, Ottawa National Forest, pers. comm. 2001)

Minnesota

Chippewa National Forest

In 1994 and 1995 call playback surveys and conspecific playback surveys were conducted on Chippewa National Forest with follow up nest searches at sites with Red-shouldered Hawk responses (McLeod and Andersen 1996). Six road survey routes 7.2 km long, consisting of 10 survey stations were surveyed 6-9 times in 1994. Only 2 routes were surveyed 7 times in 1995.

In addition to repeated road survey, approximately 48 km of roads were surveyed a single time in 1994 using conspecific playback surveys in areas identified by forest biologists as being likely Red-shouldered Hawk habitat. Of the 63 stops, 15 (24%) elicited a Red-shouldered Hawk response. In 1995, the Forest Service database was used to produce a list of all mature maple-basswood stands larger than 50 acres in size. Not all areas were surveyed, but 117 broadcasts were done April-June with 10 responses.

Two historic nest sites were known prior to 1994, one from 1992 and one from 1993. These sites were searched in 1994 and 1995, one was active in 1995. Three active nests were found in 1994 and seven during 1995. Ten other nests were found with defensive red-shoulders in the area, two in

1994 and eight in 1995. Eleven probable additional territories were located from road surveys and opportunistic sightings. And at another seven locations, Red-shouldered Hawks responded to one-time surveys. All nests occurred in areas of closed-canopy mature northern hardwoods (17 nests) or mature aspen (3 nests) with interspersed wetlands (McLeod and Andersen 1996).

Threatened and Endangered Species database shows 36 sites for Red-shouldered Hawks on Chippewa National Forest. Although, Red-shouldered Hawks are generally widely distributed at low densities throughout Chippewa National Forest, most of the known sites are concentrated at the Otter Tail Area where there is a large area of suitable habitat. Red-shouldered Hawks prefer mature hardwood habitat on Chippewa National Forest. A combination of geology, soil, and logging determines where this habitat exists on Chippewa National Forest. Minnesota has not attempted a Breeding Bird Atlas. (Al Williamson- Forest Ecologist and John Casson- Forest Biologist, Chippewa National Forest, pers. comm. 2001)

Superior National Forest

Mosher (1987) surveyed one 7.5km long route with 10 stations at .8km intervals, as part of research to develop a raptor survey method. Conspecific and Great Horned Owl taped calls were tested. A minimum of 6 replications was done on this route on Superior National Forest in 1986. As part of this project a 31.1 km^2 study area surrounding the transect route was systematically searched on foot for raptor nests. No Red-shouldered Hawks were found by the survey or foot searches.

No breeding Red-shouldered Hawks have been reported from studies nor have there been any general sightings from birders. Minnesota DNR (Maya Hamady) has hawk and owl surveys proposed for northern Minnesota during spring of 2001, but no results yet. Northern Goshawk surveys could turn up a Red-shouldered Hawk, but has not yet. Superior National Forest is northeast of the described range of the Red-shouldered Hawk in Minnesota (Coffin and Pfannmuller 1988), so they would not be expected here. Suitable Red-shouldered Hawk habitat might not be present because trees probably have not matured into the type of habitat they prefer, or perhaps the climate is too cold and the soil not fertile enough. (Edward Lindquist- Forest Biologist, Superior National Forest, pers. comm. 2001)

Wisconsin

Chequamegon-Nicolet National Forest

Chequamegon Red-shouldered Hawk conspecific callback surveys were made 1997-2000 in the Medford-Park Falls District. In some years 150 stops were surveyed, with 18 active territories located. One active nest from 2000 failed for unknown reason. One nest site from the Wisconsin Breeding Bird Atlas (Cutright et al., 2001) was recorded in the Park Falls Area. There have been five historic nest sites reported in Taylor County, but no known reproduction. Two of these five nests were confirmed to have failed. Approximately 12 students and volunteers conducted conspecific callback surveys on the Park Falls-Medford District in 2001. The goal is to cover 1-2 quads each breeding season. Nest searches will be conducted at active stops. M. Mossmen and R. Russell heard Red-shouldered Hawks calling from the south side of south Sweden Rd, west of Lake Osborn in 1991 (R. Russell pers. comm.). (Susanne Adams- Medford-Park Falls District, pers. comm.)

Several Red-shouldered Hawks were seen/heard in the spring of 2000 on the Washburn District. Wisconsin Breeding Bird Atlas reported one nest on national forest land, and DNR (Bill Smith pers. comm.) mentioned two areas with Red-shouldered Hawk activity. (Scott Anderson-Washburn District, pers. comm.)

There is little historic data for the Great Divide District: a nest in Namekagon Lake area from the early 1980's, 2 adults and 2 young from Clam Lake 1997, and two reports from Wisconsin Breeding Bird Atlas. A Red-shouldered Hawk playback foot survey of almost 3000 acres north and east of Clam Lake during the spring of 2001 had no responses. One Red-shouldered Hawk was seen in the area in mature mixed hemlock/hardwoods habitat with wet pockets. No nest was found. (Thomas Matthiae- Great Divide District, pers. comm.) (Norm Weiland-Forest Biologist, Chequamegon-Nicolet National Forest, pers. comm. 2001)

Nicolet Red-shouldered Hawk nests have been monitored by raptor biologists since 1973 (T. Erdman pers. comm.). Initially only a few nests were found, but 75 historic nest sites are now known. This does not represent an increase in population, but reflects an expansion of habitat searched, raptor surveys and opportunistic sightings. Approximately 62 sites are foot searched annually, 19 active nests are usually found and monitored for reproductive success and other nesting parameters. Most nests are on the southern district (Lakewood) (J. Jacobs 2000).

During the breeding seasons of 1980-82, K. Titus and a field crew of 2-5 people intensively foot searched woods in one quadrangle of northeastern Lakewood District for raptor nests and surveyed road routes using conspecific and Great Horned Owl call-back tapes. They located and monitored woodland raptor nests (including Red-shouldered Hawk) for productivity and measured nest site habitat characteristics. Sixteen Red-shouldered Hawk nests were found. (Titus 1984, Mosher et al. 1986, Mosher et al. 1990)

Red-shouldered Hawk conspecific call-back surveys were conducted 1992-94 at 945 predetermined stations, 109 stops had a Red-shouldered Hawk response, 210 pairs of Red-shouldered Hawks were calculated to be in the areas surveyed. A maximum of 250 pairs of Red-shouldered Hawks were estimated for all of Nicolet National Forest (Erdman and Jacobs 1994).

During the breeding seasons of 1989, 1990, and 1992, seven adult Red-shouldered Hawks were monitored with telemetry to determine habitat use and breeding range size on Nicolet National Forest (J. Jacobs and T. Erdman unpub. data).

An annual Breeding Bird Survey alternating between the southern half and northern half of Nicolet National Forest has been done since 1987 (Howe et al.1993) and several special breeding bird surveys coordinated by Bob Howe for specific nesting birds have been done in some areas. Only a few Red-shouldered Hawks have been detected by breeding bird surveys. Wisconsin Breeding Bird Atlas showed 13 quads with Red-shouldered Hawks. (Norm Weiland-Forest Biologist, Chequamegon-Nicolet National Forest, pers. comm. 2001)

Illinois

Shawnee National Forest

Limited data for Red-shouldered Hawks on Shawnee, but they have been reported from 9 Shawnee quads on the Illinois Breeding Bird Atlas. This species is a common breeding bird in the southern tip of the state. Raptor Callback Surveys in 1990, by the Illinois Natural History Survey

found Red-shouldered Hawks in Pope and Union counties (Malmborg and Vanderah 1991). (Michael Spanel- Forest Biologist, Shawnee National Forest, pers. comm. 2001)

Midewin National Tallgrass Prairie

The Red-shouldered Hawk is not a nesting bird, probably because of lack of suitable habitat. No response to Raptor Callback Surveys done in 1993 and later. Several quads of Illinois Breeding Bird Atlas had Red-shouldered Hawks northeast and west of Midewin. (William Glass- Forest Biologist, Midewin National Tallgrass Prairie, pers. comm. 2001)

Indiana

Hoosier National Forest

In 1990, Allen Parker completed a Raptor Callback Survey using the call of a Great Horned Owl. A repeat of this survey is planned for 2002 using plots and transects setup by Al Parker.

A breeding bird survey has been done for breeding seasons: 1991-93, 1995, and 2001. Purdue University will summarize these data and report in the spring of 2002.

Indiana Heritage database shows 29 records of Red-shouldered Hawks from 1983-1993. Indiana Breeding Bird Atlas (Castrale et al., 1998) showed most Red-shouldered Hawks in the southern one-third of the state. (Kelle Reynolds- Forest Biologist, Hoosier National Forest, pers. comm. 2001)

Missouri

Mark Twain National Forest

In the1986 Mark Twain National Forest Plan the Red-shouldered Hawk was listed as rare, present in small numbers in Missouri. It is a locally common permanent resident to the Mark Twain National Forest area. The Missouri Breeding Bird Atlas (Jacobs and Wilson 1997) showed Red-shouldered Hawks present in at least 34 quads of Mark Twain National Forest.

(Mary Lane- Forest Biologist, Mark Twain National Forest, pers. comm. 2001)

Ohio

Wayne National Forest

Most surveys have been on the Ironton District, and recently nest surveys have also been done on the Athens District. Forest-wide counts were taken in all mature hardwood habitat, 720 points each year 1992-94. Nest surveys were conducted on Ironton District in 1999 and 2000. Suitable habitat was searched, concentrating on hardwood forests along major streams. Approximately 1,100 miles of roads were driven. Presence/absence surveys conducted on 3,823 acres of grassy/brushy, wetland and early successional habitat in Ironton District to identify species using that habitat. Presence/absence surveys conducted on 1,792 acres of pine in 2001. The primary objective was to locate Pine Warblers but all species detected were recorded. Jeff Hays has monitored several Red-shouldered Hawk nests during the late 1990's. The Ohio Breeding Bird Atlas (Peterjohn et al., 1991) showed Red-shouldered Hawks present in at least 18 blocks or other observations on Wayne National Forest.

(Kathy Flegel- Forest Biologist, Wayne National Forest, pers. comm. 2001)

SURVEY PROTOCOL

Red-shouldered Hawk Conspecific Callback Survey Red-shouldered Hawks are difficult to locate because they are secretive, occur at low densities, inhabit large forests and are wide ranging. Most general breeding bird census methods rarely detect them. Red-shouldered Hawk Conspecific Callback Surveys have been proven to be the most effective method of surveying for breeding pairs of Red-shouldered Hawks. These surveys can also help locate active nests (Johnson and Chambers 1990, Erdman and Jacobs 1994, McLeod and Andersen 1996).

Protocol at each survey station follows Erdman and Jacobs (1994), other researchers have used similar methods successfully (Balding 1984, Mosher et al. 1990, McLeod and Andersen 1996).

Broadcast equipment consists of portable cassette tape players with MPA 25, 20-watt amplifier and 8" powerhorn, 30 Watt, 8-ohm speakers. (Commercially made amplified cassette tape players for calling predators will work also.) Vocalizations were broadcast simultaneously to both sides of the road by mounting two speakers on top of a vehicle facing opposite directions approximately 2m above the ground. Broadcast level should be 93-105 decibels at 3m directly in front of the source. This broadcast can be heard .8 km away on a calm day but only .4 km in densely forested areas after total leafout. Balding (1999) reported increased responses by increasing the volume from 95 to 130 dbl at 1m from source. Surveys should not be conducted during precipitation or when winds exceed 18 km/hr. Survey stations should be approximately .8 km apart (.5 mi).

The playback tape of a Red-shouldered Hawk call should have a series of 7 "Kee-aah" calls followed by 10 seconds of silence, this sequence should be repeated for 7 minutes, followed by 3 minutes of silence. Ten minutes is spent at each survey station. Age, gender, species, time of response, type of response (vocal only, visual only, both, perch and call, flyby and call, etc.) and estimated distance and direction to responding raptor should be recorded. Red-shouldered Hawk responses should be plotted on 7.5-minute series USGS topographic quad maps.

Some researchers repeated surveys up to 10 times at each station per season (Johnson and Chambers 1990, Mosher et al. 1990, Iverson and Fuller 1991). Some analyzed their data using a statistically based parameter, an estimate of the area occupied (AO) by Red-shouldered Hawks, an index to the relative abundance and distribution but not a measure of density. Also because raptors are not detected 100% of the time-even though they may be present-a correction factor, the probability of detection (PD), is generated to adjust the raw detection rate upward to account for birds that are present but not detected (described in Iverson and Fuller 1991). Other researchers have used both multiple visits and one visit method to survey for Red-shouldered Hawks (Belleman and Andersen 1996, McLeod and Andersen 1996). We suggest using one visit per station per season and surveying before incubation, if possible, for a basic survey. Areas to be logged should be surveyed several times if Red-shouldered Hawks are not detected on the initial surveys.

Erdman and Jacobs (1994) determined that although Red-shouldered Hawks responded well to the conspecific call during incubation, nestling and fledgling periods (47%, 40%, 46%, respectively, averaging 44%) the response rate was significantly better during the preincubation period (88%). They strongly recommended surveying during the preincubation period (mid March-mid April in the national forests of Michigan, Wisconsin, and Minnesota, Table 6). Other researchers (McLeod, Hays, via Hays pers. comm.) also recommend surveying during preincubation.

Surveyors need to be aware that the same Red-shouldered Hawks might respond at several survey stations if these stations are all within or near its territory. One adult was believed to have responded at three consecutive stations (J. Jacobs unpub. data). Incubating female Red-shouldered

Hawks will rarely call or leave the nest in response to broadcast conspecific or Great Horned Owl calls (Erdman and Jacobs 1994).

Since not all the Red-shouldered Hawks present will respond to the call, we suggest dividing the number of Red-shouldered Hawk territories detected during the survey by the rate of response (given above) to estimate the number of Red-shouldered Hawk pairs in the area surveyed (i.e. if the survey is done preincubation and 10 territories are identified, 10/.88 = 11.36, there probably are 11 active territories in the area surveyed).

Usually the national forest is too large to survey in one season. Develop a plan and prioritize the areas that need to be surveyed most. Identify the most likely Red-shouldered Hawk habitat and survey that first. Or, survey areas that are scheduled to be cut in the near future. Different sections can be done each year, taking several years to survey the entire forest. Form several survey teams. Obtain help from students, volunteers and other Forest Service staff, or contract raptor people or university students to survey.

Red-shouldered Hawk Nest Search and Monitor Walk areas of likely nesting habitat (where Red-shouldered Hawks have been seen or heard or at old nest sites) in spring before tree leafout to locate active nests. Callback surveys can determine likely sites to search for nests, occasionally even directing researchers to an active nest. Active nests should be monitored for reproductive success, habitat, nest tree, and nest parameters.

Small stands of trees (5-15 ha), that have distinct natural landscape features (streams, ridges, etc.), or manmade borders or breaks (logged-unlogged areas, change in forest type, roads, trails, right of ways, etc.) often can be searched by one person. Several people walking transects using a compass or GPS unit and a 7.5-minute series USGS topo map should search larger stands**.**

Active nests should be marked with logging tape (probably several meters away so as not to attract attention to the nest). The location should be carefully recorded on 7.5 minute series USGS topo map and the field location taken with a GPS instrument so the nest can be relocated on subsequent visits or by other biologists.

Active nests should be monitored for reproductive success by determining if the nest fledged young (successful-unsuccessful) and if possible how many young fledge. Nest success can be determined with binoculars, but accurate counts of young will require an assistant with an extendable 50-ft. pole with a small mirror attached to the top. Or use this pole with a very small security video camera attached to the top, and a hand held, battery powered TV monitor at ground level. Active nests should not be visited when the young are 34-45 days old or the young might jump prematurely. Obviously this method will not work on nests over 50 ft. high, so some nests will be monitored by ground observations only.

Climbing the nest trees, banding young, capturing and banding adults, color marking, radio telemetry, remote cameras, etc., can be done at the nest with the assistance or training of an experienced raptor biologist (special federal and state permits are usually required).

Survey Approach to Population Monitoring A survey approach would survey the entire forest or suitable habitat with conspecific playback calls, analyze data, and attempt to estimate the Red-shouldered Hawk population size on the forest. Ideally monitoring should be done every year but realistically monitoring could be done every 2-5 years. A longer interval increases the chance of hitting a population high or low, and would take longer to detect trends in populations.

Demographic Approach to Population Monitoring A demographic approach would monitor all or a sample of nest sites for numerous parameters (fidelity to nest and territory, reproductive success, nest tree and habitat parameters, disturbance, mortality, and habitat changes) and assess population changes with computer models and statistical analysis of these data. Because reproductive rates vary from year to year, long-term nest studies are valuable.

Research Priorities There is not an inexpensive, easy way to monitor the population of a raptor like the Red-shouldered Hawk. Surveying large areas with conspecific playback calls, and/or locating and monitoring nests are both expensive and time consuming. Both of these methods contribute important information for the management of Red-shouldered Hawks.

National forests can best monitor their Red-shouldered Hawks population by a combination of surveys and nest searches. Surveys can be used to assess the total picture–how many pairs and where they are, and determine population stability. Monitoring a sample of nests, random nests, or all known nests, can determine nesting problems, sometimes before the population shows fluctuation. Monitoring nests enables researchers to study reproduction, food, nest sites, breeding habitat, predators, and many other variables. Monitoring nests helps determine how to manage the habitat. Nest locations are necessary if habitat preservation guidelines like those stated in the previous section and Appendix 1 are to be implemented.

The highest priority should be to survey each forest, or at least the most likely habitat for Red-shouldered Hawks, to locate where pairs are and estimate the population on the forest. The next priority is to locate nests, monitor reproduction, and determine if that population is viable.

Each national forest needs to periodically assess:

- If they have nesting Red-shouldered Hawks
- How many nesting pairs and where are they located
- Is the population viable
- If they are not viable, why not and what can be done to stabilize or increase the population
- What habitat management is needed

Nearly all the national forests in the north central states have done some surveys for Red-shouldered Hawks. Some national forests need to do conspecific callback surveys, some need to complete surveys or survey more areas, and some need to resurvey again in the near future because it has been more than five years since they have surveyed.

GENERAL RESEARCH PRIORITIES FOR RED-SHOULDERED HAWKS

In addition to the research needs listed below see Hands et al. 1989, Peterson et al. 1992, and Crocoll 1994.

More information is needed on:

- Mortality rates and causes
- How/why Red-shouldered Hawks choose nesting sites and the role each gender plays in building the nests
- Habitat requirements of recently fledged young
- The number of non-breeding Red-shouldered Hawks in the population
- The causes of nest failures
- Migration, the dates young and adults leave breeding range, the routes they take, where they go
- Pair and site fidelity, % of pairs that return to same site

- Habitat use, where Red-shouldered Hawks roost, etc. on national forests
- Effect of habitat alteration management on breeding pairs and population
- Effect of prey fluctuation, high/low prey abundance on Red-shouldered Hawk reproduction, monitoring prey populations.

TABLES, MAPS AND FIGURES

Table 1 Wisconsin Red-Shouldered Hawk Reproduction 2000

	NNF	S.& E. OF NNF	CEN WI	TOTAL
# OF SITES CHECKED	57	33	31	121
Previously active sites	57	32	31	120
New sites	0	1	0	1
# OCCUPIED SITES	25	23	25	73
# OF ACTIVE NESTS FOUND	18	16	17	51
# OF NESTS SUCCESSFUL	7	10	11	28
% OF NESTS SUCCESSFUL	39%	63%	65%	55%
# OF YOUNG FLEDGED	13	20	22	55
YG/ACTIVE NEST	.72	1.25	1.29	1.08
YG/SUCCESSFUL NEST (BROOD SIZE)	1.86	2.00	2.00	1.96

NNF= NICOLET NATIONAL FOREST
S.& E. OF NNF = NE WI: Door, Brown, S. Oconto and Marinette Counties
CEN WI= Wood and Portage Counties

TABLE 2 RED-SHOULDERED HAWK REPRODUCTION for WISCONSIN 1991-2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	**10 YR. AVE.**
SITES CHECKED	107	106	105	114	119	148	150	130	110	121	**121**
OCCUPIED SITES	-	-	72	67	74	83	82	61	68	73	**73** ACTIVE
NESTS FOUND 56	58	60	51	56	55	58	51	57	51		**56**
NESTS SUCCESSFUL	30	27	19	25	28	18	39	32	33	28	**28**
%NESTS SUCCESSFUL	54%	47%	32%	49%	50%	33%	67%	63%	58%	55%	**51%**
YOUNG FLEDGED	68	52	41	61	47	35	95	77	82	55	**61**
YG/ACTIVE NEST	1.21	.90	.68	1.20	.86	.64	1.64	1.51	1.44	1.08	**1.11**
YG/SUCCESSFUL NEST (BROOD SIZE)	2.27	1.93	2.16	2.44	1.74	1.94	2.44	2.41	2.49	1.96	**2.18**

TABLE 3 Comparison Of Red-Shouldered Hawk Reproduction For Nineteen Studies

SOURCE OR RESEARCHER	# Of NESTS,	% SUCCESSFUL,	LOCATION, YEARS, RANGE	NUMBER OF YOUNG PER ACTIVE NEST
JACOBS	51	55%	NE & C WI 2000 (range .72-1.29)	1.08
JACOBS	557	51%	NE & C WI 1990-99 (range .36-2.00)	1.13
EBBERS	73	66%	N L MI 1986-88 (range 1.1-2.7)	1.60
CRAIGHEADS	61	-	S MI 1942,47,48 (range 1.7-1.9)	1.80
COOPER++	89	73%	N L MI 1999-2000 (range 1.61-1.9)	1.61
Mc LEOD ET AL.	20	15%	CHIPPEWA NF MN 1994-95	1.00
Mc LEOD ET AL.	48	60%	CAMP RIPLEY MN 1994-95	-
ADAMS	2	0%	CHEQUAMEGON NF WI 2000	0.00
DYKSTRA ET AL.	195	61%	SW OHIO 1997-99 (range 1.5-2.1)	1.76
STRAVERS	60	-	IO & SW WI 1983-94 (range .45-2.04)	1.52
BEDNARZ	8	88%	IOWA 1979	2.90*
DIJAK ET AL.	34	-	MISSOURI 1982-83	1.79
CROCOLL ***	9	56%	W NEW YORK 1989	1.10
JOHNSON	39	72%	C NEW YORK 1989	1.40
ARMSTRONG +	6	83%	S ONTARIO 1982	1.80
JANIK & MOSHER	17	53%	W MARYLAND 1982	1.80
STEWART	52	-	MARYLAND 1947	2.54*
WILEY	29	66%	CALIFORNIA 1973	1.34
HENNY	74	-	MARYLAND 1943,49,60-71 (range .50-3.33**)	1.58
HENNY'S RECRUITMENT RATE REVISED (HENNY ET AL. 1973)				**1.95**

* these are the only two studies for which reproduction exceeded Henny's Recruitment Rate
** large variation in range is due to small sample size of 6 nests/year
*** CROCOLL & PARKER
+ ARMSTRONG & EULER
++ COOPER AND CUTHRELL

TABLE 4 LIFE TABLE MODEL COMPARISON OF POPULATION IN EACH AGE CLASS, HENNY TO JACOBS

PARAMETERS	HENNY	JACOBS
1st yr mortality	58%	50%
2nd+ yr mortality	30%	22%
Breeding starts	2 yrs	2 yrs
females produce yg	82%	51%

yg/successful female	2.6	2.18
AGE CLASS	**% OF BIRDS IN AGE CLASS**	
0-1 yr olds	42%	31%
1-2 yr olds	18%	15%
2+ yr olds	40%	54%
m(x) for breeding adults	1.066	.5559
total for e^(-rx)l(x)m(x)	1.000081	.961151
instantaneous rate of increase, r	5.31686E-03	-7.545925E-03
finite rate	1.005331	.9924825
oldest adult	15 yrs	21 yrs

Life Tables computed by PD: Population Dynamics modeling, version 4.0 (c) 1989 by J.W. Grier, Zoology Dept., N.D. State Univ., Fargo, ND, using Henny's information (1972) and data for WI (J. & E. Jacobs 2000).

TABLE 5 Results Of A Deterministic Simulation Model Of A Red-Shouldered Hawk Population For A Variety Of Probable Mortality Rates

Trial #	1st yr mortality	2nd yr and older mortality	Population After 50 yrs
1	56%	20%	1043
2	54%	21%	896
3	51%	22%	916
4	51%	21%	1548*
5	**50%**	**22%**	**1097**
6	50%	21%	1851
7	49%	23%	773

8	48%	23%	923*

*Age distribution at end of simulation for trial #4 and #8 respectively:

0-1 yr olds	31%	30%
1-2 yr olds	15%	16%
2+ yr olds	54%	54%

For all trials: females normally begin breeding at 2 yrs old, percent females successfully breeding = 51%, young per successful nest (or per successful female) = 2.18, 50 yr simulation starting with 1000 hawks (100, 100 males/females of the year age 0-1, 100, 100 males/females 1 yr old, and 300, 300 males/females 2 yrs and older).

Deterministic Simulation done with ***Population Dynamics Modeling: Version 4.0*** copyrighted by James W. Grier, Zoology Dept., North Dakota State University.

TABLE 6 RED-SHOULDERED HAWK BREEDING PHENOLOGY FOR NORTHEASTERN WISCONSIN (includes Nicolet National Forest)

Year	**1st RS return to nest site**	**Incubation begins mean (range)**	**Eggs Hatch mean (range)**	**Young Fledge mean (range)**	**N**
1996	3.04	4.25 (4.14-5.06)	5.30 (5.21-6.10)	7.10 (6.29-7.22)	8
1997	3.10	4.18 (4.13-4.26)	5.23 (5.18-6.01)	7.03 (6.28-7.12)	17
1998	--	4.13 (4.9-4.18)	5.18 (5.15-5.23)	6.28 (6.23-7.02)	12
1999	3.07	4.13 (4.7-4.16)	5.18 (5.12-5.21)	6.28 (6.20-7.01)	16
2000	3.05	4.06 (3.29-4.18)	5.11 (5.04-5.24)	6.21 (6.13-7.04)	14
5 yr Mean	**3.07**	**4.15 (3.29-5.06)**	**5.20 (5.04-6.10)**	**6.30 (6.13-7.22)**	

Dates are Month**.**Day: March 4th = 3.04, N = number of nests monitored each year. Arrival dates from field observations of J. Jacobs, 5 yr mean was calculated from annual means, incubation, hatching, and fledging dates were calculated from measurements of young taken at banding time, and field observations. A 36 day incubation period, and a 42 day nestling period was used to calculate age of young.

TABLE 7 SPRING PHENOLOGY FOR NORTHEASTERN WISCONSIN 1996-2000

Year	1st Robin/ Red-winged Blackbird	1st Chipmunk out	1st Wood Frog calling	1st/Peak Trillium blossom	Trees leaf out	1st Lilac blossom	1st Tiger Swallowtail Butterfly
1996	3.12 3.10	3.15	3.17	5.17 5.26	5.20	5.26	5.28
1997	3.12 3.08	3.12	4.13	5.18 5.27	5.23	5.23	6.02

1998	2.27	2.24	3.27	4.30	5.01	5.04	5.18
	2.28			5.11			
1999	3.16	3.01	4.02	5.01	5.01	5.05	5.05
	3.28			5.10			
2000	2.21	2.26	3.27	4.27	5.01	--	5.31
	2.26			5.10			
5yr	**3.06**	**3.04**	**3.30**	**5.06**	**5.09**	**5.15**	**5.23**
Mean	**3.08**			**5.17**			

Dates are Month.Day: March 4th = 3.04

Locations of sightings:
American Robins/Red-winged Blackbirds, Chipmunk, and Lilac sightings from Green Bay WI,
Frogs, Trillium, leaf out, and Tiger Swallowtail observations from woods 15-30 miles north of Green Bay (Suamico, Oconto Falls, and Shawano). Data from: Prusik et al., 1997-2001, Elaine Friedrick pers. comm., and J. Jacobs pers. obs.

Common and scientific names:
American Robin *(Turdus migratorius*), Red-winged Blackbird (*Agelaius phoeniceus*), Eastern Chipmunk (*Tamias striatus*), Wood Frog (*Rana sylvatica*), Large-flowered Trillium (*Trillium grandiflorum*), Common Purple Lilac (*Syringa vulgaris*), Eastern Tiger Swallowtail (*Papilio glaucus*).

TABLE 8 1996-2000 SPRING WEATHER RELATING TO PHENOLOGY OBSERVATIONS AND RED-SHOULDER HAWK BREEDING

1996 March was cold, northern Wisconsin and Michigan were buried in snow on the 31st. Bird migration and plant phenology were eight days behind normal. April was colder and snowier than average. Phenology averaged 13 days behind normal. Winter-like in northern Wisconsin at months end. Many lakes from Mountain northward were still iced over on the 23rd. May was the third abnormally cold month in a row, phenology averaged two weeks behind normal.

1997 March was colder than normal with a deep snow cover in northern Wisconsin. Phenology was about three days behind. April started warmer but phenology was still three days behind normal by the end of the month. May was cooler and more cloudy than normal, frequently with northeast wind. Plant phenology fell behind normal by an average of eight days.

1998 March shocked Wisconsin residents with its return to winter temperatures on the 7th after a very warm Feb. Phenology was 30 days ahead of normal on the 1st but only 16 days ahead by the

31st. April was warmer and drier than normal, thanks to El-Nino. The plant phenology averaged 10 days ahead of our 10-year normal, but felt weeks earlier because last spring was cold and late. May was warm and dry. Plants were 10 days ahead of normal.

1999 February and March were warmer and drier than normal, with good snow cover in the far northern part of the state. Phenology averaged 14 days ahead of normal. April was warmer and drier than normal. May saw near normal temperatures and moisture but soil was still dry. Plants averaged a week ahead of normal at month's end. The dryness kept it from being farther ahead.

2000 February was much warmer than normal. March was warmer than normal with less than normal precipitation. April was warmer and drier than normal. Dryness can delay plant blooms and warmth can speed them up. So, there was a mixture of early and normal phenology. May started warmer and drier than normal. On the 10th a change to cooler and wetter conditions relieved a mild two year drought.

Source: Prusik et al. 1997-2001

TABLE 9 RELATIVE ABUNDANCE OF FIVE WOODLAND RAPTORS THROUGHOUT THE NORTH CENTRAL STATES FROM BREEDING BIRD ATLAS SURVEYS.

	Frequency of detection in percentage of blocks covered				
State	**RSHA**	**BWHA**	**COHA**	**RTHA**	**BDOW**
IA	**3**	**4**	**9**	**75**	**39**
MO	**12**	**12**	**7**	**78**	**40**
WI	**14**	**40**	**41**	**73**	**41**
IN	**16**	**12**	**21**	**83**	**38**
MI	**17**	**35**	**22**	**58**	**23**
OH	**17**	**23**	**33**	**94**	**52**
IL	**5**	**5**	**5**	**72**	**28**
MN	**NOT AVAILABLE***				
AVE.	**12**	**19**	**20**	**76**	**37**

* A breeding bird atlas has not been attempted for Minnesota.

RSHA- Red-shouldered Hawk, BWHA- Broad-winged Hawk, COHA- Coopers Hawk, RTHA- Red-tailed Hawk, BDOW- Barred Owl

TABLE 10. PERCENT OF PREY ITEMS DELIVERED TO RED-SHOULDERED HAWK NESTS.

State or Province	No. Nests	No. Prey Items	Mammals	Herps	Birds	Fish	Invertabr.	Unk.	Source
New York	16	--	58	21	8	--	10	3	Ernst 1945
Maryland	17	43	33	46	19	--	2	--	Stewart 1949
Wisconsin	9	318	52	22	3	3	19	--	Welch 1987
Maryland	17	31	77	20	3	--	--	--	Janik & Mosher 1982
Massachusetts	7	46	72	24	4	--	--	--	Portnoy & Dodge 1979
Iowa	7	164	25	25	2	--	18	30	Bednarz & Dinsmore 1985
Michigan	29	573	22	29	28	--	21	--	Craighead and Craighead 1956
Quebec	8	241	50	41	5	<1	1	2	Penak 1982

All data from prey items only, no pellets.

TABLE 11. HABITAT CHARACTERISTICS FROM 0.04 HA (0.1 ACRE) RED-SHOULDERED HAWK NEST PLOTS.

STUDY	NEST TREE Height (m)		NEST TREE DBH (cm)		NEST HEIGHT (m^2/ ha^{-1})		BASAL AREA Water (m)		DISTANCE TO (m)		
	X	SE	X	SE	X	SE	X	SE	X	SE	
DYKSTRA ET AL. OHIO N=63 *	30.9		1.1		65.7	3.9	34.2	2.6	30.2	8.7	---
JACOBS AND HNILICKA WI N=19	24.4		2.0		52.2	10.1	31.9	0.8	45.1	33.3	14.3 2.8
Bednarz and Dinsmore Iowa n=12	28.6	4.6	63.0	12.7	---	---	142	120	19.1	4.8	
Dijak et al. MO n=34 *	28.4	3.1	61.3	12.8	27.5	10.6	---	---	17.2	2.6	
Cooper and Cuthrell MI n=44	25.3	0.56	50.1	1.8	--	--	362	97	14.1	0.37	

- Results from combined data of two study areas/samples.

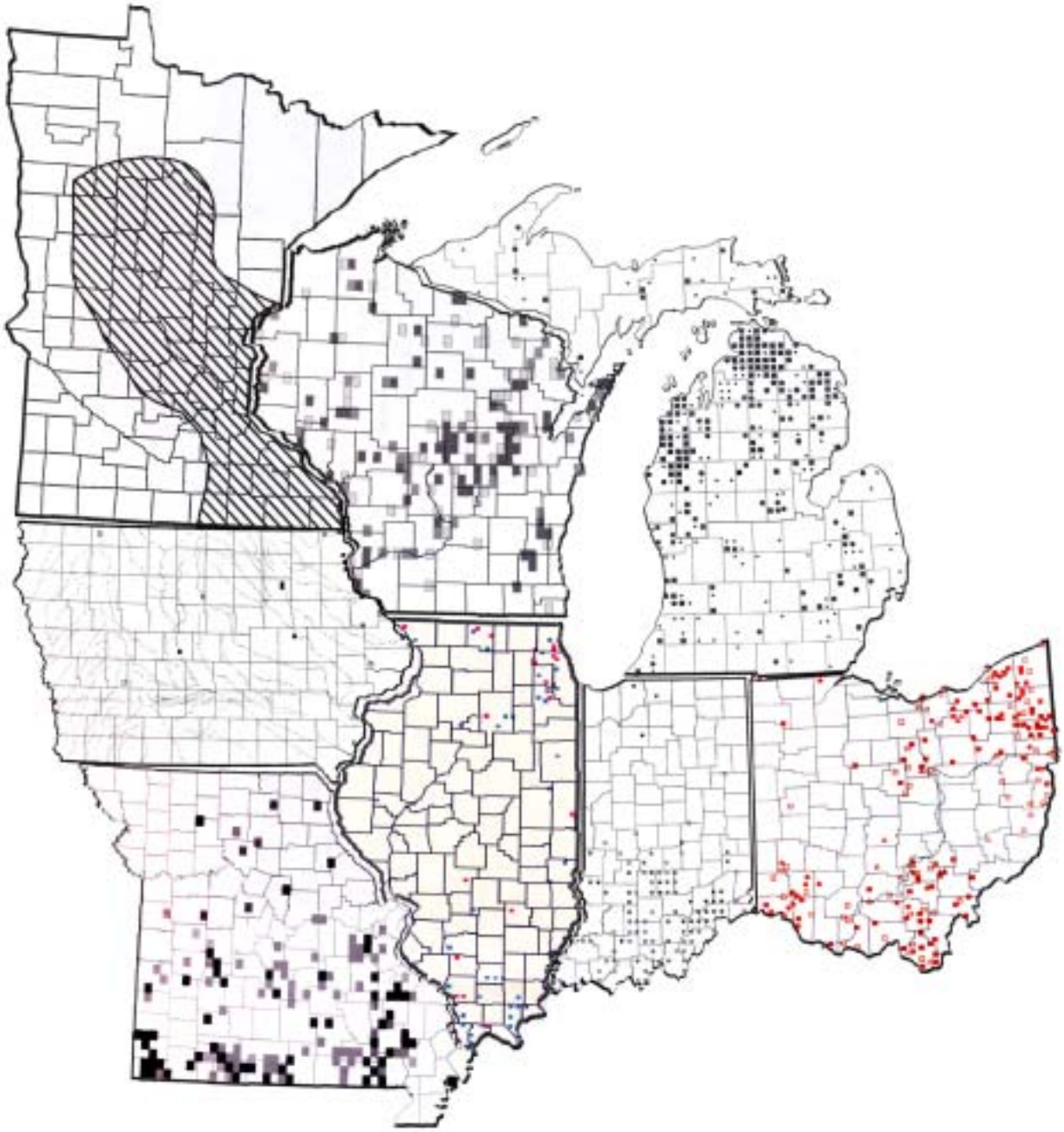
TABLE 12. TREND ANALYSIS OF RED-SHOULDERED HAWK NUMBERS FROM BBS DATA.

	|----------1966-1999 Trends----------|				|-----1966-1979----			-| |-----1980-1999-----|	
AREA	**Trend**	**P**	**N**	**(95%**	**CI)**	**R.A.**	**Trend**	**P**	**N**	**Trend** **P** **N**
Michigan	12.6	0.30	10	-9.4	34.6	0.06	--	--	--	9.0
Illinois	1.1	0.84	9	-8.9	11.0	0.04	-9.6	0.46	5	20.6
Minnesota	-2.4	0.37	2	-5.4	0.6	0.03	--	--	--	-6.4
Wisconsin	-13.3	0.11	12	-28.1	1.4	0.02	-23.8	0.37	5	4.5
N New England	34.9	0.40	11	-41.4	111.2	0.07	-5.9	0.82	5	14.0
Cent. BBS Region	1.5	0.44	159	-2.4	5.5	0.69	8.5	0.02	51	0.4
Eastern BBS Region	1.5	0.04	557	0.1	2.9	0.41	-0.5	0.74	212	2.7
U.S. and Canada	2.5	0.00	774	1.0	4.0	0.47	2.0	0.22	282	2.7

Source: Sauer, J. R., J. E. Hines, I. Thomas, J. Fallon, and G. Gough. 2000. *The North American Breeding Bird Survey, Results and Analysis 1966 - 1999. Version 98.1, USGS Patuxent Wildlife Research Center, Laurel, MD*

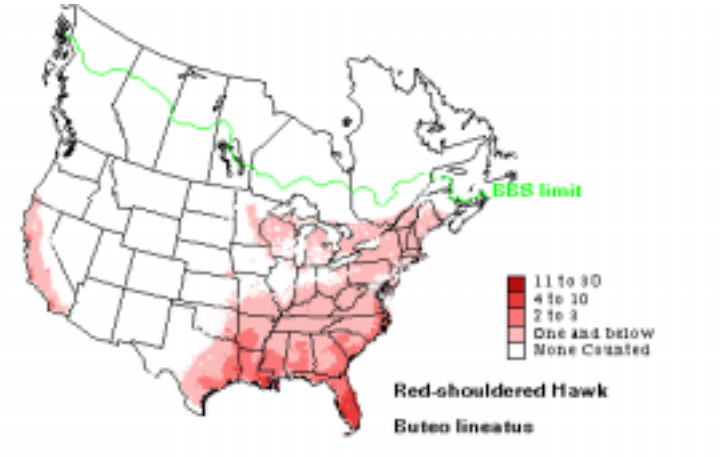
Map 1. Distribution of Red-shouldered Hawk for North central States from State Breeding Bird Atlases

Solid black or red squares are confirmed breeding sites, all other markers are probable or possible breeding sites, diagonal line shaded area is range of Red-shouldered Hawks in Minnesota. From: Coffin & Pfannmuller 1988, Brewer et al. 1991, Peterjohn & Rice 1991, Jacobs & Wilson 1997, Jackson et al. 1996, Castrale et al. 1998, Kleen 1998, Cutright et al. 2001.

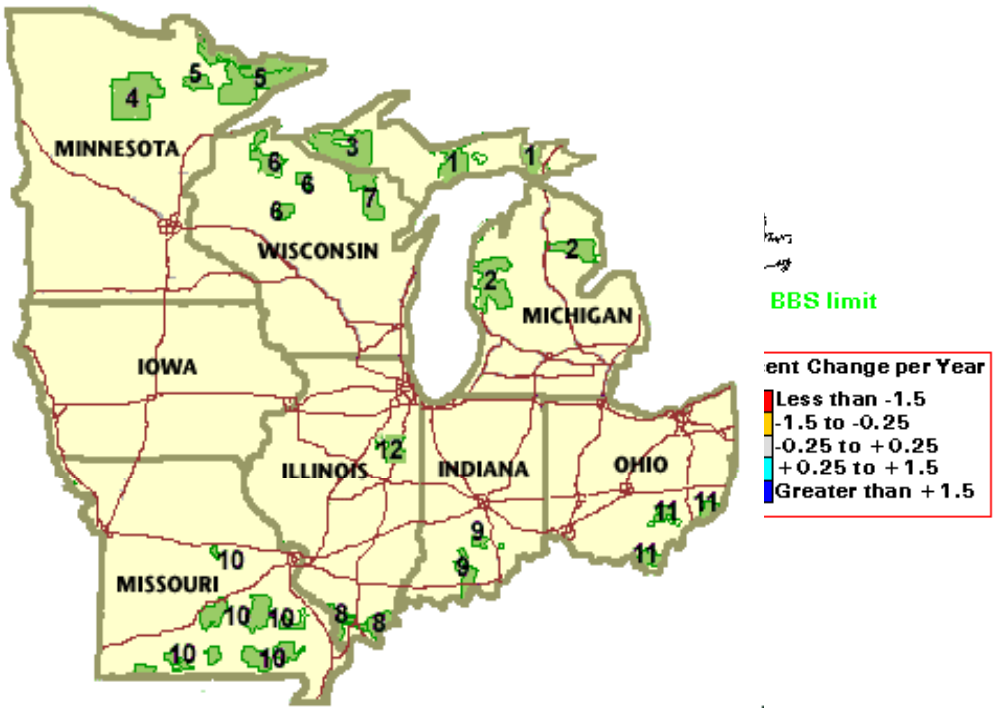


MAP 2. BREEDING DISTRIBUTION OF RED-SHOULDERD HAWK
(for United States and Canada)

Compiled from Breeding Bird Survey-Sauer et al. 2000, Clark and Wheeler 1987, Coffin & Pfannmuller 1988, Brewer et al. 1991, Castrale 1991, Peterjohn & Rice 1991, Jacobs & Wilson 1992, Crocoll 1994, Jackson et al. 1996, AOU 1998, Castrale et al. 1998, Kleen 1998, Sibley 2000, Cutright et al. 2001.



MAP 3. RED-SHOULDERED HAWK POPULATION TRENDS FROM BBS DATA
Modified from Breeding Bird Survey-Sauer et al. 2000



MAP 4. NATIONAL FORESTS OF NORTH CENTRAL STATES

MICHIGAN
1. Hiawatha
2. Huron-Manistee
3. Ottawa

WISCONSIN
6. Chequamegon
7. Nicolet

INDIANA
9. Hoosier

Minnesota
Chippewa
5. Superior

Illinois
8. Shawnee
12. Midewin

Missouri 4.
10. Mark Twain

Ohio
11. Wayne

Figure 1. WINTER POPULATION TRENDS FOR RED-SHOULDERED HAWK *Buteo lineatus* 1959-1988

Graph of survey-wide yearly indices from CBC, from Sauer et al. 1996

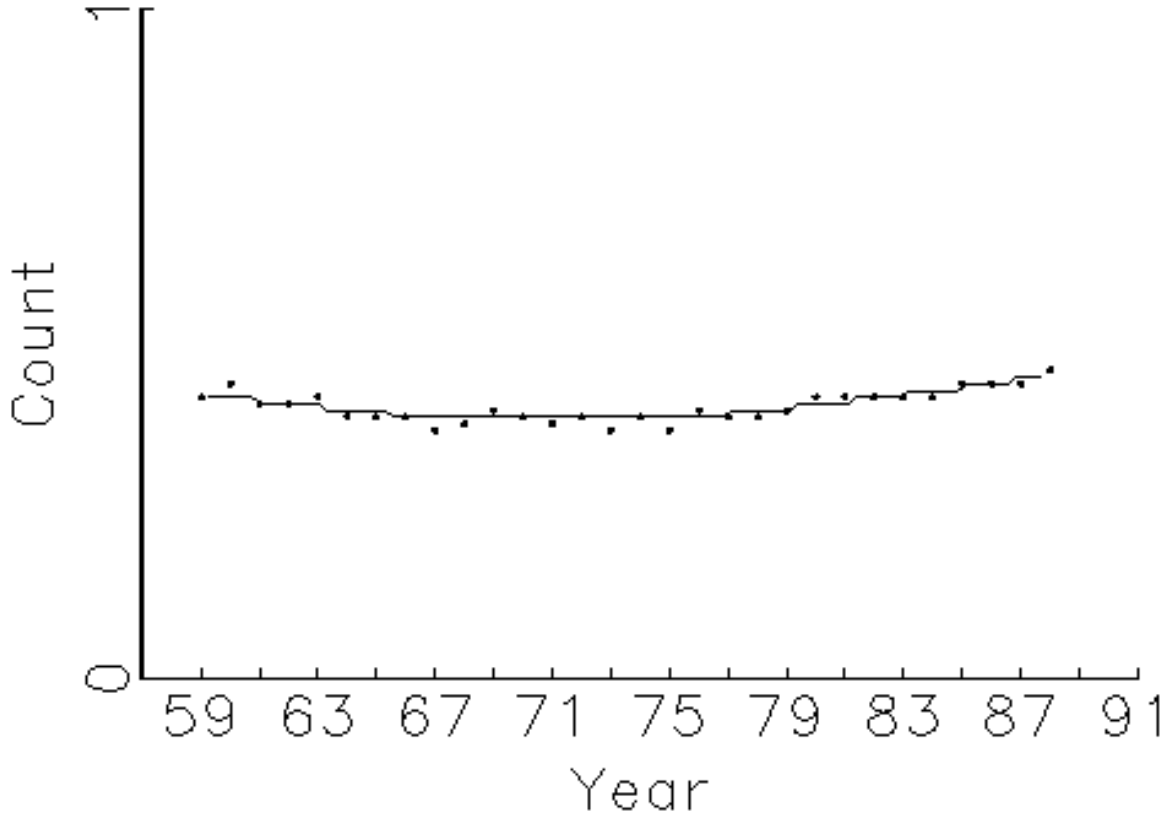
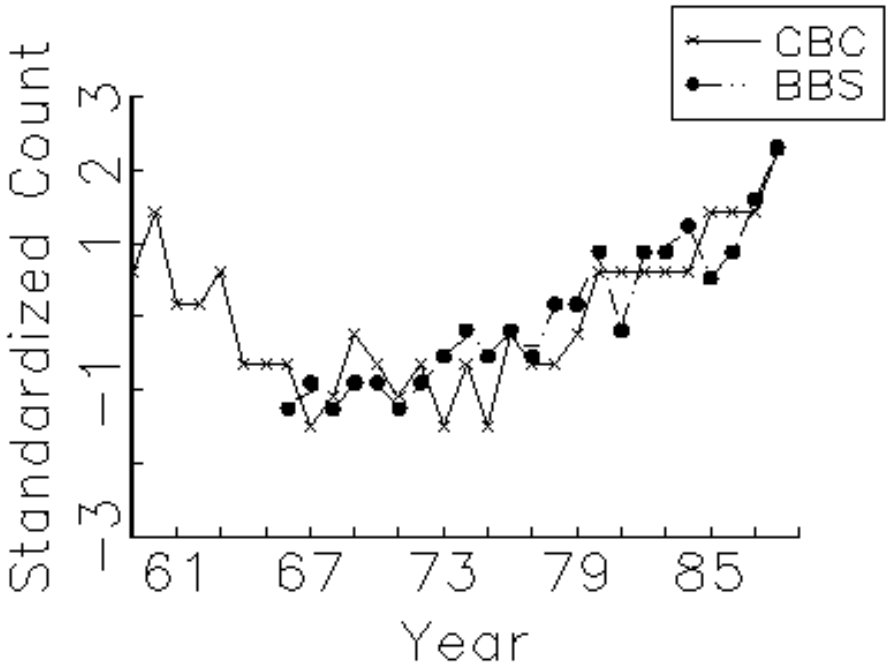


FIGURE 2. POPULATION TRENDS FOR RED-SHOULDERED HAWK *BUTEO LINEATUS* 1959-1988 FROM CHRISTMAS BIRD COUNTS AND BREEDING BIRD SURVEYS

Graph of survey-wide yearly indices from CBC and BBS, from Sauer et al. 1996



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APPENDICES
Appendix 1

Draft

MANAGEMENT GUIDELINES FOR RED-SHOULDERED HAWKS ON STATE-OWNED LANDS IN MICHIGAN

[Developed by the Woodland Raptor Working Group]

Introduction

The Red-shouldered hawk (*Buteo lineatus*) is listed as threatened in the state of Michigan. The species historically had a statewide distribution but since the early 1950s has not been a common resident of the southern lower peninsula. Known nesting areas now exist in the northern lower peninsula. Nesting occurs sporadically in the southern lower peninsula. Declines are thought to be due to the loss of extensive, mature lowland forests. Confirmation of nesting in the Upper Peninsula was not recorded until 1978 (Postupalsky 1980). Breeding evidence has been found in eight upper peninsula counties since then (Brewer et al. 1991). The Atlas of Breeding Birds of Michigan confirms 115 nesting sites in Michigan.

In northeastern Iowa, Bednarz and Dinsmore (1982) recommend maintaining woodlands averaging 123 ha of floodplain forest and 70 ha of upland forest within one kilometer of a nest. They also suggest that each pair may require a territory as large as 615 acres. The same study also suggested that mature forests be maintained at 370 to 1,000 trees for every 2 ½ acres with openings comprising around 15% of suitable habitat.

Surveys and habitat analysis in the summer of 1998 by the Michigan Natural Features Inventory found that most (93%) active nest sites were located in upland deciduous forest with 61% of them occurring in stands with even-aged structure. Wetlands appear to be an important component in the nesting sites; 57% were located within 1/8 mile of a wetland. Forest patch size was >3000 acres for 56% of the nest sites; and patches of at least 200 acres held 20% of the nesting sites.

Upland deciduous forest appears to be an import factor for Red-shouldered hawks in the northern parts of Michigan, contrary to most studies that have found bottomland or floodplain forest to be important. The southern habitats appear to be composed of bottomland forest and are more similar to those described in the literature.

The majority of nesting birds arrives from wintering areas between late February and early April. They are highly territorial, making nesting areas relatively easy to locate due to their aggressive vocalizations. Territories are utilized for several consecutive years, often using several nests within the territory (Craighead and Craighead 1956). Red-shouldered hawks usually obtain most of their prey from openings created by wet meadows within forested areas (Bednarz and Dinsmore 1985). A comprehensive study in southeastern Michigan found nesting Red-shouldered hawks to prey most heavily upon small rodents and birds, with a lesser emphasis on snakes, frogs, and crayfish (Craighead and Craighead 1956). Other studies have found diets consisted of mostly small rodents (Ernst 1945: Portnoy and Dodge 1979) while others have documented a variety of birds, reptiles, amphibians, and insects (Barrows 1912: Stewart 1949: Pettingill 1976).

OBJECTIVES

The objectives of these guidelines are to identify Red-shouldered hawk habitat requirements to provide management recommendations to the Michigan Department of Natural Resources which (a) maintain or increase the number of successful nesting pairs and (b) define when and where to manage for Red-shouldered hawks and associated species on state-owned land.

USE OF GUIDELINES

These management guidelines are intended for upland hardwood forests north of the transition line in the lower peninsula. Southern Michigan nesting areas are generally located in bottomland forests and are linear in shape along water courses. Currently there are too few nests in the southern population to evaluate nesting situation and develop guidelines.

HABITAT REQUIREMENTS

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

Nesting habitat in northern Michigan
Nesting habitat primarily consists of well-stocked pole or sawtimber stands (stocking densities 6 and 9) with a closed canopy (80-100%) and basal area of at least 80 square feet per acre.

Canopy closure less than 80% tend to encourage red-tailed hawk (*Buteo jamaicensis*) occupancy. Wetlands also are an important component of Red-shouldered hawk nesting habitat. Nesting areas usually are located within 0.25 to 0.50 mile of wetlands or other water bodies. Red-shouldered hawks exhibit a high degree of nest site fidelity, and often return to the same nest tree or alternate among several suitable nest sites within the same nesting area from year to year. Suitable nest trees typically exceed 18 inches in diameter and contain a sturdy crotch near the main trunk in the lower portion of canopy. Nests have been found in a variety of tree species (typically deciduous, e.g., beech and maple), but ultimately tree structure is the limiting or determining factor. Finally, Red-shouldered hawks can be extremely sensitive to disturbances in the immediate nesting area, particularly early in the nesting season when prolonged or frequent disturbances can lead to nest abandonment.

FORAGING HABITAT

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

MANAGEMENT GUIDELINES

Each nest area may contain more than one nest tree and overlapping of zones within a nest area will occur. The Nest Tree Zone is that which immediately surrounds the nest tree. This is surrounded by the Buffer Zone which is surrounded by the Tertiary Zone. The total acreage of all zones around a nest tree should approximate 385 acres.

NEST TREE ZONE

Definition:

- five (5) chain radius from nest tree (-330 feet)

- ~ 8 acres

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

BUFFER ZONE

Definition:
- five (5) chain radius beyond Nest Tree Zone (330-660 feet)
- ~ 24 acres

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

TERTIARY ZONE

Definition:
- northern hardwoods or mixed hardwoods and conifers (660-2310 feet)
- 25 chain radius beyond Buffer Zone
- ~ 354 acres
- maintain 80% average canopy closure

Guidelines:
- total openings will not exceed 10% (35 acres) of total area
- no planned activity March 1 through August 31
- modification of size on openings requires consultation with a DNR Wildlife Biologist and/or NFI staff

GENERAL GUIDELINES

Zones should focus on the nest tree (i.e. the nest tree should be as close to the center of the defined zones as possible). Shape of zones need not be maintained in a circle if forest or landform structure deems it impractical. In that case acreage recommendations will be applied. However, unsuitable habitat (as defined in Habitat Requirements) should not be included in the total acreage of any zone.

The definition of opening is an area in which the height of a cover type is less than the surrounding type. Two-five year old (or six to eight feet high) aspen may function as an opening for Red-shouldered hawks.

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

FUTURE DIRECTIONS

Continued surveys to gather more distribution and nest area characteristics are planned. Upon gathering sufficient data, core areas of the northern forests will be defined. These core areas will serve as the primary management areas for the Red-shouldered hawk and other species that require large tracts of mature forest. The core areas will be chosen on the basis of the amount of appropriate habitat, number of active nests, and the potential for population growth. Geographic Information Systems (GIS) will be utilized to map existing habitat areas as well as identifying potential management areas. Compromises with timber management and other user groups will need to be made during future phases of management guideline development and will be addressed as they arise.

Southern forest nesting areas (south of the transition line) will continue to be monitored and population growth will be encouraged to the extent possible in the smaller forest tracts. Comprehensive surveys of Red-shouldered nesting areas are needed.

These guidelines are intended to be a living document that can be modified as needed to accommodate new information that will benefit the Red-shouldered hawk and associated species. They are currently meant to provide guidance for the management and future expansion of this species. They are not meant to be adopted as DNR policy as this time.

"BIG TREE" SILVICULTURE IN NORTHERN HARDWOODS

These guidelines are written to provide old growth attributes and greater diversity to manage Northern hardwood stands while continuing to provide quality wood products for human consumption. It is intended to be used in stands to complement adjacent "old growth" areas and to provide another silvicultural management choice for Northern Hardwood forest cover type.

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

H. R/R snags and large woody debris. Much of this will be recruited from other categories and remaining trees not specifically relegated to any of these categories. This recruitment will come about from natural death, girdling and other such activities. Residue from logging activities can be designed to provide additional wood debris.

I. R/R regeneration gaps. Provide three to five crown gaps per acre every ten to fifteen years. Gaps should vary in diameter from 30 to 60 feet and should equal approximately eight percent of the crown cover area. For areas to be managed for the Red-shouldered hawk, make no more than one regeneration hole per acre.

J. R/R a number of trees of species that have been removed from the Northern Hardwood type. Examples include white pine, oak, hemlock, cedar and ground hemlock. This may require planting in larger regeneration gaps and protection from deer.

2) For stands that are best characterized by the 1.7 "Q" curve, i.e. heavily stocked with trees in the 6, 8, 10 and 12 inch DBH classes:

A. R/R all native species common to the Northern Hardwood type including some of moderate tolerance.

B. Identify 50 crop trees per acre and perform a Crop Tree Release. Trees identified as crop trees should include as many different tree species and as many "super crown" trees as possible.
Additional trees can also be marked as long as the overall crown cover does not drop below 80%. While there is no direct correlation between basal area and percent crown cover, residual stocking after marking should be in the 70 ft^2 to 80 ft^2 basal area range.

C. R/R dying trees. Between one and five live trees per acre should be marked for girdling in order to hasten the development of snags, dying trees and dead and downed timber. Also, retain high risk trees that: have the least crown cover competition; have the least value for wood products; and, have the greatest wildlife and diversity value.

D. R/R both den and nest trees. In addition, the goal should be to perform a "Crop Tree Release" on one potential raptor nest tree per acre.

E. Make between one and five 30 to 50 foot regeneration holes per acre. For areas to be managed for the Red-shouldered hawk, make no more than one regeneration hole per acre.

F. R/R tree species that have been eliminated from the northern hardwood type, e.g. white pine, hemlock, oak, cedar and ground hemlock. This may require planting in larger regeneration gaps and protection from deer.

3) For stands that are best characterized by the 1.5 "Q" curve, i.e. acceptable representation in the 10, 12, 14,16 and 18 inch DBH classes but overly stocked in the 6 and 8 inch DBH class, follow the guidelines for the 1.7 "Q" curve given above.

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

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

LANDSCAPE APPROACH TO RED-SHOULDERED HAWK MANAGEMENT

I. Attempt to identify Red-shouldered hawk core area(s)* within each forest area.

*A core area is an area of suitable or optimal habitat (see guidelines on Red-shouldered Hawk habitat requirements) in which Red-shouldered Hawk nests appear to be concentrated. Ultimately, the core area should be an area in which Red-shouldered Hawks are not only using but also successfully reproducing. Forest management within the core area should focus on protecting and providing habitat for Red-shouldered Hawks.

A. Obtain operations inventory (OI) map for entire forest area. (We estimate that it would take 1 person potentially 2 to 3 weeks to generate or acquire this map).
    1. Potential sources
        a. Individual forest areas
        b. FMG GIS shop in Lansing has most of the forest area OI maps available in digitized format.
    2. Consult MIRIS 1978 land cover for nests and habitat that occur on adjacent private lands. Also, the MIRS land cover maps are a good alternative if forest area-wide OI maps are not available.
B. Plot known Red-shouldered Hawk nest sites/occurrences in forest area (1 person, est. 1 week).
    1. Potential sources of occurrence or nest site data
        a. MNFI BCD
        b. Forest records
        c. Forest area personnel
C. Delineate core area (team of 2-4 people, est., 1-2 meetings).
    1. Identify cluster of nest sites on forest area OI map.
    2. Delineate area by identifying large mosaic(s) of contiguous mature deciduous forest of stocking class 6,8, 9 with adjacent wetland complexes around cluster of nest sites. Major changes in cover types from suitable to unsuitable habitat (e.g., from large patches of mature deciduous forest to large areas of young deciduous forest (e.g., stocking class 1, 2, 3, 4) or upland coniferous forest) may represent or act as core area boundary.
    3. When Red-shouldered Hawk occurrences do not appear to be concentrated in a particular area or if data on Red-shouldered Hawk nests in forest area are insufficient to delineate a core area, see III.

II. Management within core areas.
A. Known nest sites
    1. Same as previously agreed upon nest site guidelines?
        a. 7.5 ac. No cut buffer around nest tree

b. Secondary and tertiary buffers around nest tree may not be necessary if big tree management is applied to the entire core area.

B. Potential habitat/habitat between or surrounding nest sites (rest of core area)
    1. Big tree management
C. Survey for additional nests and monitor known nests.
D. Evaluate management strategy.
    1. Potential questions to ask
        a. Are more Red-shouldered Hawks nesting in the area, and are the birds successfully reproducing? Does the core area boundary need to be adjusted?
        b. How is management of core area impacting other species or other forest values, such as economics or recreation?

Appendix 2
Brief Description of Survey and Research Methods

General breeding bird surveys are most effective measuring populations of songbirds, not raptors. They are of some value because they are widespread and have been done on most national forests. Woodland raptors, including Red-shouldered Hawks, are especially difficult to detect and monitor because they are secretive, occur at low densities, are wide ranging, and the forest habitat presents major observational barriers. Intensive effort was expended during the 1980's and early 1990's to develop effective and affordable ways of surveying woodland raptors and statistical methods of interpreting the results (Fuller and Mosher 1981, 1987, Mosher 1987, Devaul 1990, Iverson and Fuller 1991). All researchers have concluded that broadcast taped calls of a Great Horned Owl or conspecific calls of the raptor being surveyed greatly increased the detection rate compared to rates obtained by only looking and listening from the roadside. Broadcast conspecific taped vocalizations along a road route is the most effective and efficient way to detect breeding Red-shouldered Hawks (Johnson and Chambers 1990, Mosher et al. 1990, Erdman and Jacobs 1994, Belleman and Andersen 1996, McLeod and Andersen 1996).

Breeding Bird Atlases (BBA) A multi-year (3-5yr) effort was made to locate and document the breeding birds within each state. Each state is divided into a grid of atlas blocks based on USGS 7.5-minute topographic maps. Maps are divided into six blocks comprising 25 kilometers each; one of the six blocks is randomly selected for intense surveying. The goal is to locate every bird species breeding in a block and confirm breeding for as many as possible. Most blocks were searched on foot many times in a 3-5 year period. Often playback tapes of many species of birds were used. The distribution and abundance of each bird species nesting in the state is plotted out on a map. Coordinated by state DNRs, Audubon, Birding, and Conservation Societies, hundreds of people participate. In our opinion, it is the most reliable statewide information of breeding birds, including raptors.

The North American Breeding Bird Survey (BBS) Developed by Chandler Robbins and launched in 1966, the original 600 survey routes east of the Mississippi River was expanded to 2000 by 1968. Today approximately 2900 of 3700 active routes are surveyed annually. Usually conducted during June, each route is 24.5 miles long with 50 stops. A three-minute point count is conducted at each stop; observers record all birds seen or heard, but rely mostly on the song of breeding birds. This survey was designed to provide continent-wide perspective of bird population changes. BBS data are challenging to analyze. Rare birds, like raptors or birds at the edge of their range, tend to be poorly represented. (Sauer et al. 2000)

Breeding Bird Census (BBC) Initiated in 1914 by the former US Bureau of Biological Survey, it has been administered more recently by the National Audubon Society and Cornell Laboratory of Ornithology. Standard vegetation and breeding criteria are used to establish breeding bird and vegetation communities. Methods are sometimes modified for a specific study. Usually conducted during June, at dawn or very early morning, a 3-10 minute point count is conducted at each predetermined stop. Hundreds of stops are identified and can be along a road or at the end of a lengthy walk into specified marked sites. Observers record all birds seen or heard. It relies on the song of the

breeding birds. It is usually coordinated with an ornithological society, university, ornithologist, or avid birder, and 10-150 experienced birding volunteers. General breeding bird surveys rarely detect raptors but are good methods to assess the songbird population.

Roadside Counts of Raptors Observers record all raptors seen or heard as they drive slowly (17-40 km/hr.) along a designated route with stops every .8 km. Binoculars and spotting scope are used to aid identification. Data recorded and locations of raptors are plotted on maps. Survey data are used to map raptor distributions, calculate relative abundance, estimate densities and note habitat use. (Fuller and Mosher 1987 *in Raptor Management Techniques Manual*)

Raptor Callback Survey Observers travel a designated route (length varies with area being surveyed), stopping at predetermined points every 1.3 km. At each stop the observers broadcast the amplified tape recorded call of a great horned owl for five minutes, and then watch and listen for a response from a raptor for five minutes. Responses are recorded and mapped. Routes are sometimes repeated up to 10 times during the same breeding season. It is more effective at detecting raptors than Roadside Counts of Raptors. (Mosher et al. 1990, Iverson and Fuller 1991 *in proceedings of the Midwest Raptor Management Symposium and Workshop*)

Red-shouldered Hawk Conspecific Callback Survey Similar to the Raptor Callback Survey except that a Red-shouldered Hawk call is played instead of a great horned owl. This method is sometimes useful in locating active nests and is more effective in detecting Red-shouldered Hawks than Raptor Callback Survey. (Erdman and Jacobs 1994, McLeod and Andersen 1996)

Red-shouldered Hawk Nest Search and Monitor During the breeding season before trees leaf out**,** habitat is systematically searched by driving roads, walking trails and walking forest looking for nests, and hawks. Areas around previous nests or areas where hawks have been seen or heard are checked first. Other field people sometimes report nests encountered in their work. Conspecific Callback methods can sometimes help locate nests. Active nests are monitored for success. (Craighead and Craighead 1956, Jacobs and Jacobs 2000)

Capture, Mark and Recapture Hawks are captured (Adults are captured with special nets, lures and live traps. Young are captured in the nest before they can fly by climbing the nest tree.) and banded with U.S. Fish & Wildlife Service metal bands and sometimes with additional colored bands or markers. (If recovered later, usually found dead by general public, or if recaptured by the same or another bander or if a color marked bird is sighted and reported.) This method usually supplements other raptor survey techniques, and can be used to estimate densities, monitor reoccupancy, dispersal, and turnover rates and determine reproductive success. Data on age, gender, physical measurements, etc., can be obtained. (Fuller and Mosher 1987 *in Raptor Management Techniques Manual*)

Monitoring Breeding Red-shouldered Hawks with Telemetry Hawks are captured, banded and a small radio transmitter is attached to a tail feather or to the hawk's back with a harness. The transmitter sends out a signal that is translated into an audio beep by a receiver monitored by a field person on foot or in a vehicle. A yagi antenna, hand held or mounted on a vehicle, is used to determine the signal's direction. The loudness of the signal indicates the closeness and direction of the hawk. Locations of hawks are determined by triangulation and/or visual sightings. Intimate details of the hawk's life can be

obtained, like breeding range size, habitat use, roost location, etc. (Dykstra et al. 2000)

Christmas Bird Counts The longest running and largest ornithological database, the Christmas Bird Count, began on Christmas Day, 1900 at 25 eastern US cities. Now more than 50,000 volunteer birders, at over 1800 sites throughout North America, spend one day between Dec. 15 and Jan 5 searching a designated circle 15 miles in diameter-about 177 square miles. During a 24 hour calendar day they search for every bird within the designated circle, recording numbers of birds seen or heard, mileage and hours spent afield, time and the number of people watching feeders. Christmas Bird Counts annually monitor the status and distribution of resident and migratory bird populations during early winter, although there are some biases in the method. (Geoff LeBaron 2000 Christmas Bird Count methods)

Appendix 3

Definition of Terms

Breeding Range is the total area used by a pair of Red-shouldered Hawks during the entire breeding season.

Dispersion is the patterns in which Red-shouldered Hawks distribute themselves over the landscape in relation to habitat, food, predators, competitors, and other factors. Dispersion defines the spacing between nests and/or territories and the use of various habitats.

Home Range is the area used by the bird or pair over the entire year or even several years, and is more applicable to birds that do not migrate.

Nest or active nest is the structure used by the hawks that year to hold their eggs. Nests used in previous years are called previous nests, former nests or old nests. A site might have 1-5 old nests in addition to the active nest.

Nest Site or site refers to the area around the nest(s), both the active and previously used nests (if any), for that pair. Nest site, site, and territory are often used interchangeably referring to the area used by a pair of hawks where the location of at least one nest is known.

A population is a group of organisms of the same species occupying a particular space. A population has a reproductive rate and mortality, a growth form, density, age structure, and a numerical dispersion in time and space (Smith 1966).

Population dynamics or population biology is the attempt to explain animal numbers in space (locally or regionally) and in time (seasonal or annual fluctuations) (von Haartman 1971).

Population viability or population sustainability is the ability of a species to maintain a population level that is stable or increasing over the foreseeable future, barring a catastrophic disaster.

Pair Fidelity The same birds remain paired to each other, often returning to the same site year after year. Red-shouldered Hawk pairs were "believed" to "mate for life" (Bent 1937) i.e. a pair remains

together or reunites each breeding season at the same nest site until one of them dies. The survivor attracts a new mate from a "floating population" of unmated birds waiting to join the breeding population and continues the dynasty. It was also believed that since hawks are long lived, a breeding pair would return for many breeding seasons. Bent (1937) found that if one hawk is shot at a nest site it is often replaced within 15 days. Jacobs and Jacobs (unpub. data) found that within 3 years, 44% of the breeders have disappeared, within 5 years, 63% have disappeared. So, the majority of nesting Red-shouldered Hawks will disappear within 4 years. Only 10% return to a site for 10 years or longer. What has happened to the hawks that do not return? Initially it was assumed that all birds that did not returned had died. Although Red-shouldered Hawks have a maximum longevity of 20 yr, their life expectancy is low with an estimated average survival of 25.6 months (Keran 1981). Band recoveries for three sites (2f, 1m) (Jacobs and Jacobs, unpub. data) verify that non-returning birds had indeed died. But, it was also found that birds occasionally moved to another site < 5km away (2m, 3f, the disposition of the former mate is unknown. It might have died). Jeff Hays (pers. comm.) also recorded at least one female moving to a new site while her mate remained and attracted a new female at the old site. It appears that males have a higher fidelity to the nest site than females. Long term telemetry or mark-recapture studies are needed.

Productivity is a measure of the reproductive success by determing the number of young produced per pair, per active nest, and/or per successful nest (Tables 1-3). Number of young per pair can be difficult or impossible to determine since Red-shouldered Hawks can be very secretive. Therefore this measure of productivity is seldom used.

Territory, or nesting territory, is the area around the nest that is defended by the pair of birds. Adjacent pairs might have edges of breeding ranges that overlap by 6-11% (McCrary 1981). A hawk’s nesting territory is usually slightly smaller than it’s breeding range.

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