[illegible]ivity, Population Trend, and Status of Northern Goshawks, [illegible]cipiter gentilis atricapillus, in Northeastern Wisconsin

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[illegible]il the late 1960s, Northern Goshawks, *Accipiter gentilis atricapillus*, were considered rare breeders in Wisconsin. [illegible]search initiated in 1971 revealed a small but growing breeding population, which continued to increase until the mid-[illegible]80s when depredations by mammalian predators began to reduce numbers. Since 1985, reproduction has fallen below the [illegible]imated threshold of 1.7 young fledged/active nest needed to maintain a stable population. The reintroduced Fisher, [illegible]*rtes pennanti*, is largely responsible for increased nest failure and adult female mortality, with the turnover rate of nest-[illegible] females having doubled to over 40%. Twenty-two years of reproductive data reveal a correlation between population [illegible]els and the 10-year wildlife cycle. The goshawk has been listed as a "sensitive species" since 1986 in the Nicolet [illegible]tional Forest, and guidelines have been established for nest site protection. However, no such standards exist for state, [illegible]unty and private lands, where populations are declining. Legal and illegal "take" of nestling goshawks is a continuing [illegible]ncern, especially as nest sites under national forest management become more vulnerable to falconers, who have taken [illegible] estimated 5% of young from monitored nests.

[illegible]y Words: Northern Goshawk, *Accipiter gentilis atricapillus*, productivity, 10-year cycle, population trend, territory longevity, model, Fisher, *Martes pennanti*, predation.

T[illegible] hern Goshawk *Accipiter gentilis atri-pil*[illegible] [illegible]as considered a rare summer resident in [illegible]isconsin since at least the middle of the 19th [illegible]ntury (Kumlien and Hollister 1903). By 1900, [illegible]ost of the climax forests of mixed northern hard[illegible]oods, White Pine, *Pinus strobus*, and Red Pine, [illegible]*inus resinosa*, had been logged and repeatedly [illegible]rned. Goshawks in northeast Wisconsin proba[illegible]y persisted in uncut, unburned refugia, such as [illegible]e 930 km² Menominee Indian Reservation. [illegible]ugust Schoenebeck (1902: Kiff, personal com[illegible]unication 1983) documented the state's first nest[illegible]g records in Oconto County near the reservation [illegible]ith the collection of four egg sets between 1885 [illegible]d 1902. From then until 1968 there were only 10 [illegible]dditional nesting territories recorded, all in five [illegible]orthern counties (Robbins 1991).

The discovery of five nests, by Erdman, and Gary [illegible]lin of the Wisconsin Department of Natural [illegible]esources (WDNR), in Oconto, Forest, and [illegible]arinette Counties in the late 1960s, initiated the [illegible]udy being reported. One territory located in 1968 [illegible] the Nicolet National Forest (NNF) was still active [illegible] 1993.

The objective of the project, initiated in 1971, [illegible]as to investigate Goshawk population ecology, [illegible]articularly predator/prey relationships, habitat utilization and effects of forest management. The Goshawk research was part of a larger, long-term project which also included monitoring Broad-winged Hawks, *Buteo platypterus*, and Red-shouldered Hawks, *Buteo lineatus*. The project was entirely self-funded, and pursued on extended weekends and/or while investigators were on annual leave. The rarity of Goshawk nest sites constrained the choice of available methodologies and made systematic search of the entire study area for nests impractical. We believe these Goshawk data provide a reasonably random sample and reflect overall conditions in Wisconsin. We follow the definitions of Postupalsky (1974) for breeding territory (hereafter territory), nest, active nest and successful nest. An active nest is one in which at least one egg is laid and a successful nest is one from which at least one young was fledged.

Study Area

The initial study area was 600 km², in Oconto, Forest and Marinette Counties, but because of the rarity of breeding territories it was expanded to 12 northeast and north-central counties including the Door Peninsula (Figure 1). The area involved is all of northeastern Wisconsin north of 44°30′N, and east of 90°W, including the entire 2650 km² NNF,

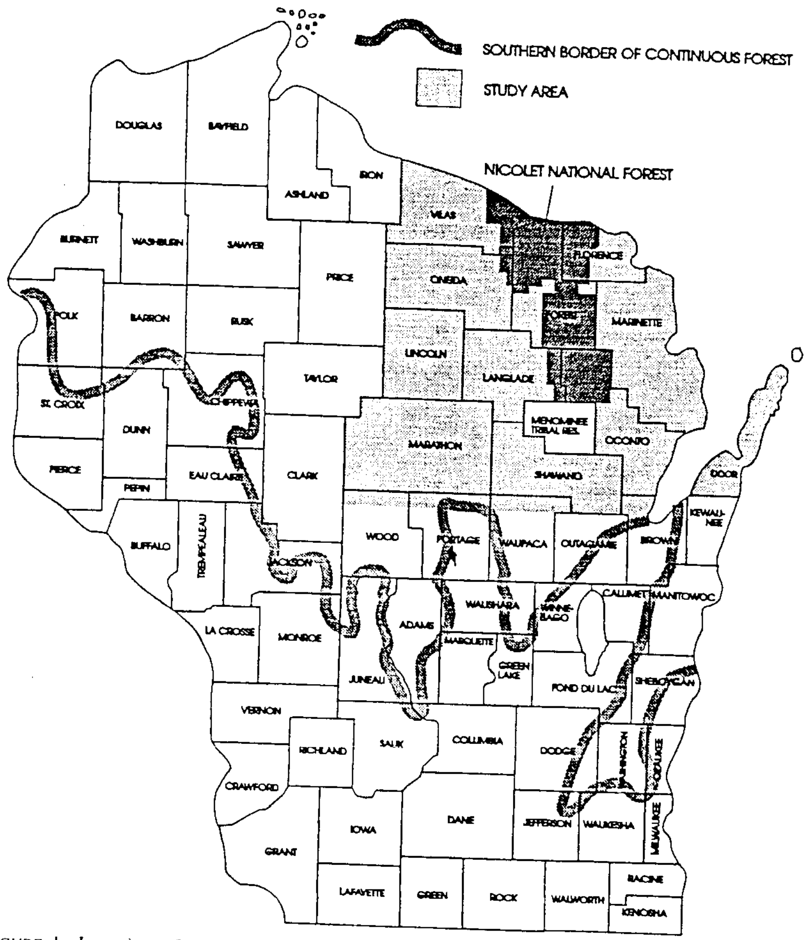


FIGURE 1. Location of the study area in northeastern Wisconsin and the southern extent of continuous northern forest in Wisconsin.

with the exception of the Menominee Indian Reservation. Except for the reservation, most of this area was logged and repeatedly burned prior to 1900. Poor soils and a short unpredictable growing season made attempts to farm cleared lands largely unsuccessful, resulting in much of the land being vacant and tax-delinquent by the 1920s. Large tracts were converted to public ownership as federal, state and county forest lands. Aspen, *Populus tremuloides*, and Paper Birch, *Betula papyrifera*, predominate, along with short-rotation Red Pine, *Pinus resinosa*, and Jack Pine, *Pinus banksiana*, used for paper production. Continued demand for pulpwood coupled with increasingly mechanized harvesting methods favors clear-cutting of large uniform blocks up to 259 ha in size. At present, much of the county and private forest land is already in the second or third rotation of aspen/birch regeneration. Selectively logged stands are succeeding to shade-tolerant Red Maple, *Acer rubrum*, Sugar Maple, *Acer saccharum* Balsam Fir, *Abies balsamea*, and Eastern Hemlock *Tsuga canadensis*. The Door County peninsula is a exception to this pattern, as the climate moderation of Green Bay and Lake Michigan make it ideal fo orchards and tourism. Much of the sub-boreal fores bordering the Lake Michigan shoreline is still intact Due to a tremendous tourism industry, logging i almost nonexistent there and several relatively large state parks harbor mature maple, Beech, *Fagus grandifolia*, and hemlock forests. For detailed information on the climate, geology and biota of the study area see Curtis (1959) and Robbins (1991).

Methods

Territory Activity

New territories were located by searching suitable habitat and through a network of contacts that included U.S. Forest Service, Wisconsin DNR log-

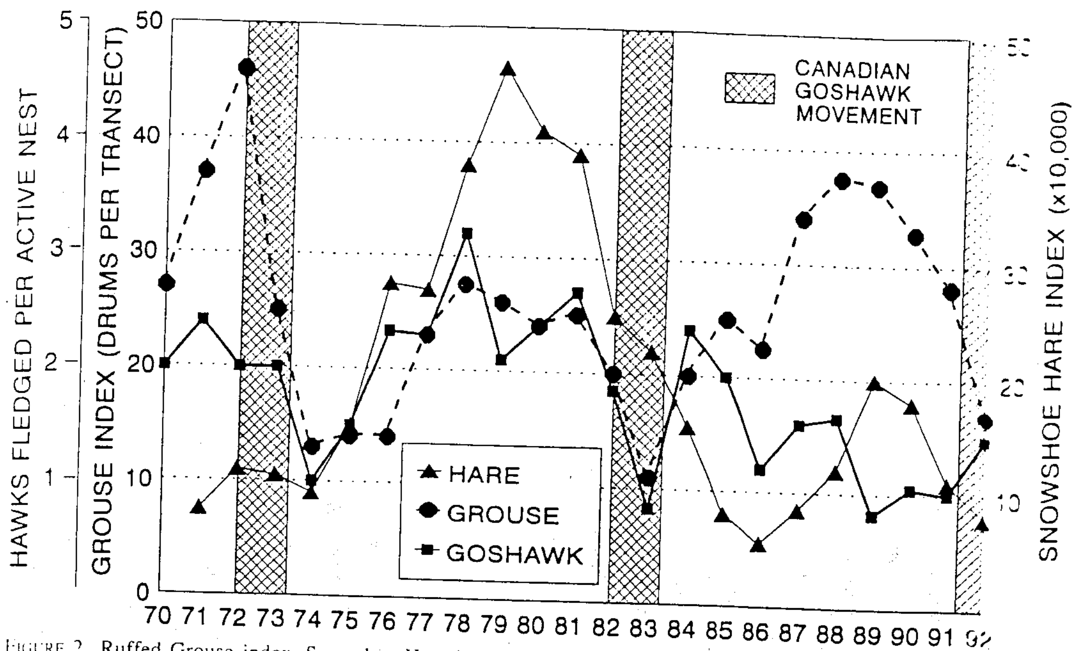


FIGURE 2. Ruffed Grouse index, Snowshoe Hare index and Northern Goshawk reproductive success in northeastern Wisconsin between 1970 and 1992.

g t fishermen, falconers and bird watchers, as we other interested individuals. In 1986, the Goshawk was listed as a sensitive species on NNF, requiring nest site protection. We conducted workshops and field training in identification of woodland raptor nests for NNF personnel. As a result of their interest and cooperation, the number of known territories on NNF has since doubled. The level of effort expended to verify territory activity varied between years, but has increased each year as more known territories were identified.

Beginning in March of each year, all known territories were checked for activity. When territories were abandoned, we continued to search them each spring until all old nest structures disappeared or substantial habitat changes occurred; e.g., logging or development. Time spent assessing individual territories each spring varied from as little as 15 minutes to as much as 12 person-days per site, depending upon activity. Typically, one researcher would examine the nest with binoculars from several vantage points to ascertain status. If an adult was not present at the previous season's nest or known alternate sites, an extensive search was conducted for a new nest. The small number of nesting territories allowed time for repeated thorough ground searches of surrounding habitat for a new nest up to a 1-km radius from the original nest location. This distance exceeds the greatest separation that we observed between any pairing of alternate nests within territory.

To prevent desertion during incubation we did not climb nest trees and we have been very cautious about flushing incubating birds. In 1988, because of an increase in nest failure from mammalian depredation, we began placing greased metal baffles (1 m tall) around nest trees at banding time. However, because of continued serious nest failures during incubation, in 1992 we began installing these guards midway through incubation. This has improved reproductive success without resulting in increased abandonment.

Trapping and Banding

We did not attempt to trap adults until the young were at least 10 days old. In the early 1970s we used bal-chatris baited with Gerbils, *Meriones unguiculatus*, Starlings, *Sturnus vulgaris*, or feral pigeons, *Columba livia*, and dho-gazas adjacent to a live or mounted Great Horned Owl, *Bubo virginianus*. In 1975 we switched to the use of two mist-nets (121 mm mesh, 210 denier), a live owl and a cassette tape recorder playing Goshawk vocalizations. The latter technique was extremely effective, allowing us to examine and mark 100% of the females and 9?% of the males at successful nest sites in most years. In addition, mist-net use provided added protection to both Goshawks and the lure owl by preventing grappling which is dangerously uncontrollable with a dho-gaza set. Mist-nets also allowed for double catches when both adults were present. Typically however, the female was trapped first and later the

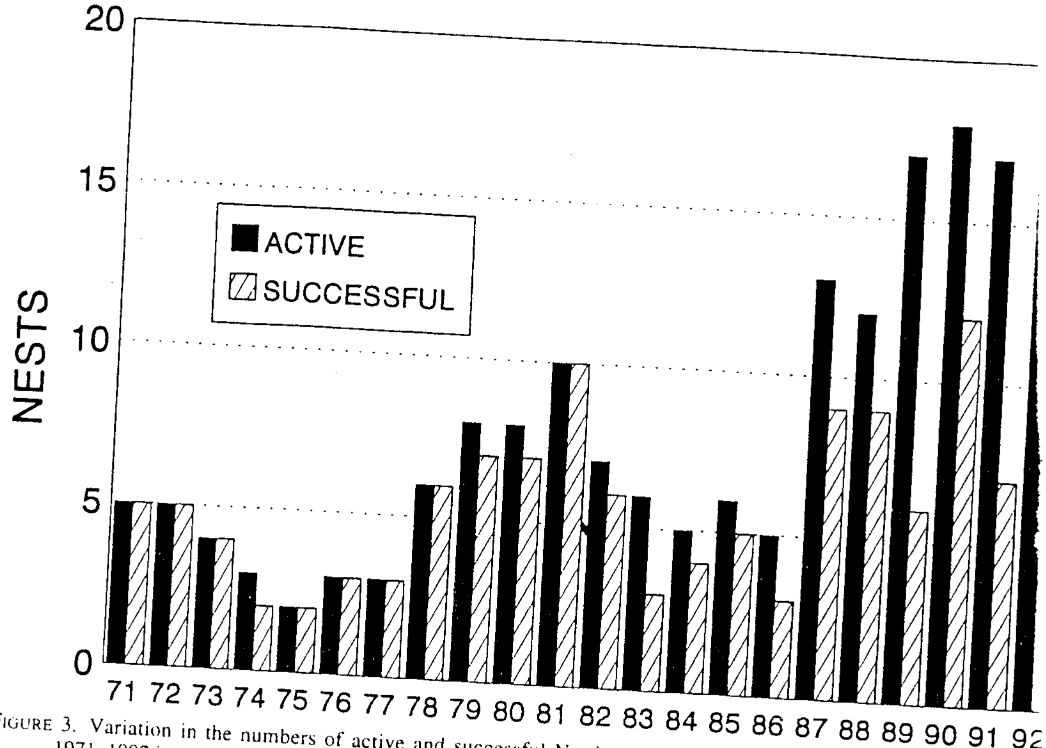


FIGURE 3. Variation in the numbers of active and successful Northern Goshawk nests monitored each spri 1971–1992 in the northeastern Wisconsin study area.

male on his return with prey. The adults were held in appropriate holding tubes while the nest tree was climbed and the young banded. Adults were aged, sexed, weighed, measured, and marked with U.S.F.W.S. bands before release. A third visit was made to a territory post-fledgling to assess chick survival.

Snowshoe Hare, Ruffed Grouse and Fisher Population Estimates

Because both the quantity of prey available and presence of significant predators affect Goshawk population trends, we used data made available from WDNR's Bureau of Wildlife Research on the relative size of Snowshoe Hare, *Lepus americanus*, Ruffed Grouse, *Bonasa umbellus*, and Fisher, *Martes pennanti* populations through the years. For prey species we utilized the mean number of drums/transect from the spring drumming counts taken in northern Wisconsin as an index of breeding densities and population size for Ruffed Grouse, and the annual hunter harvest of Snowshoe Hare as an index of hare abundance (Figure 2). Collection of prey remains and pellets from plucking perches and nest sites has shown the two main prey items to be Snowshoe Hare and Ruffed Grouse, although many other species are also taken (unpublished data). To evaluate the relationship between Goshawk reproductive success and prey densities, an index of prey availability was constructed from the WDNR dat with Prey Index = (Snowshoe Hare index^2 * Ruffe Grouse index)$^{1/3}$. The index was weighted towar Snowshoe Hares because hares weigh approximatel 2.7 times more than Ruffed Grouse and represent greater return on foraging time investment. The cub root was used to return the index value to the rang of the primary index values.

WDNR Fisher population estimates were based on age and sex ratios, presence of corpora lutea and placental scars of harvested animals and Winter Furbearer Track Counts (Kohn et al. 1992). Additional information was obtained from Jon Gilbert, Great Lakes Indian Fish and Wildlife Commission biologist, who is engaged in long-term telemetry studies of Fisher in north-central Wisconsin.

Statistical Methods

To test for differences between two means we used *t*-tests. ANOVA and the Student-Newman-Keuls test for mean separation were used to test for differences between more than two means. Simple linear regression was used to test for the relationship between prey-index value and Goshawk reproductive success (young fledged per active nest). The alpha level used for rejection of all null hypotheses was $a = 0.05$. All statistical analyses were performed using SAS tical package (SAS Institute Inc. 1987).

TABLE 1. Distribution by forest ownership of Northeastern Wisconsin Northern Goshawk breeding territories.

Forest Ownership	Territories	Currently Active (%)	Logged (%)	Occupied by Great Horned Owls (%)
County	16	2 (13)	10 (63)	4 (25)
Private	16	3 (19)	8 (50)	2 (13)
Nicolet National Forest	40	17 (43)	14 (35)	3 (8)
State	5	3 (60)	2 (40)	1 (20)
Totals	77	25 (32)	34 (44)	10 (13)

Results

Territory Activity

Of the 77 territories found between 1968 and 1992, 8 were inactive when found, apparently abandoned due to logging, and 69 provided reproductive information. Between 1968 and 1992, 270 years of territory histories were collected, with the total of known nesting territories growing from 5 in 1971 to 69 by 1992. In 1992 at least some degree of activity was observed in 25 territories. Through the 22 years from 1971 through 1992, 181 active nests were found, ranging between 2 in 1975 and 18 in 1990 and 1992 (Figure 3). The number of active nests [illegible]d approximately 50% during each of the two [illegible]cent prey population declines (Figure 2 and 3). The average distance between nest clusters defining the centers of adjacent active territories was 8.8 km, with a minimum of 1.6 km being observed three times, all during years of peak prey densities.

Mean breeding territory longevity was 3.9 years, with ranges of 1 to 26 years. As of 1992, selective or clear-cutting within 100 m of nests had occurred at 34 territories [44% of the total and 65% of the inactive territories] (Table 1). Territory longevity was significantly greater on state-owned lands, 10.2 years, than all of the other categories; and shortest on county forest land, 2.4 years (Table 2).

Productivity

Goshawk reproduction between 1968 and 1992 is summarized in Table 3. Overall productivity in this 25-year span was 1.6 young fledged per active nest and 2.1 young fledged per successful nest. Before 1982 in only 3 of the 11 years were there failures of active nests, with 54 of 57 (94.7%) being successful (Figure 3). Significantly, in 1982 to 1992, nest failures occurred *every* year, and only 78 of 124 (62.9%) succeeded, with over half failing (21 of 34 (62%)) in 1989 and 1991 (Table 3).

Annual productivity, measured as young fledged per active nest, ranged from a 1978 high of 3.2 (n = 6 nests) to lows of 0.8 in 1983 and 1989 (n = 6 and 17 nests, respectively) and was directly correlated to the prey index (P = 0.0097, adjusted $R^2 = 0.243$) (Figure 2). The number of young fledged per successful nest was equal to the number fledged per active nest, except for three years, prior to 1982. In contrast, every year from 1982 through 1992 the number fledged per successful nest has been lower than the number fledged per active nest (Figure 4). This pattern of diminished success became pronounced starting in 1983 and became most apparent from 1988 through 1991 when a severe drought combined with an outbreak of Forest Tent Caterpillars, *Malacosoma disstria*, led to defoliation of trees in the study area.

Most if not all of the productivity loss was the result of Fisher predation, mainly during incubation (Figure 3). During this time, turnover rates, based on recapture and recovery data for breeding females, doubled. In 1990, we recovered the carcasses of four breeding females at nest sites (n = 17 nests). All had been killed and consumed by Fishers.

The number of young birds taken by falconers from the monitored nests was substantial (5%) and female-biased. The known annual take by falconers varied from a low of 0 to a high of 17% in 1979.

TABLE 2. Northeastern Wisconsin Northern Goshawk breeding territory longevity by forest ownership.

Forest Ownership	Territories	Territory Years	Years Active (Range)	Mean Longevity*	Still Active in 1992 (%)
County	15	36	1 - 5	2.4[a]	2(13)
Private	15	59	1 - 10	4.0[a]	3(20)
Nicolet National Forest	34	124	1 - 26	3.7[a]	17(50)
State	5	51	2 - 17	10.2[b]	3(60)
Totals	69	270	1 - 26	3.9	25(36)

*Means with different superscripts were significantly different (ANOVA, F = 5.358, P = 0.002).

TABLE 3. Northern Goshawk reproductive success in northeastern Wisconsin for time periods between 1968 anc

Time Period	Nest Attempts	Successful Nests	Percent Successful	Young Fledged	Young Fledged/ Active Nest	Young Fledged/ Successful Nest
1968-1992	184	135	73	288	1.6	2.1
1968-1992[1]	184	138	75	304	1.7	2.2
1971-1981	57	54	94[2]	122	2.1[3]	2.3
1982-1992	124	77	62[2]	160	1.3[3]	2.1

[1] Includes young taken for falconry, n=16.
[2] Significantly different (t-Test, t=4.857, P<0.001).
[3] Significantly different (t-Test, t=3.044, P=0.006).

Prey populations

Snowshoe Hare and Ruffed Grouse population fluctuations for the period 1970-1992 are shown in Figure 2. The conspicuous 10-year cyclic fluctuations from peaks to valleys of these two sympatric species were apparently linked (Keith 1963; Rusch et al. 1978). Although they showed considerable synchrony, it was also obvious that their population amplitudes varied between 10-year cycles in both magnitude and in the timing of analogous phases of the cycle. Wisconsin hare and particularly grouse populations are directly affected by the periodic autumn "invasions" of Canadian Goshawks following hare population crashes farther north (Keith and Rusch 1988). Major invasions, each exceeding 5500 individuals, were documented in 1972 and 1982 at Hawk Ridge, Duluth (D. L. Evans, personal communication.).

Fisher Populations

Prior to settlement by Europeans, Fishers were common in heavily forested areas of Wisconsin. Deforestation and fur-trapping drastically reduced the population by the end of the 19th century (Petersen et al. 1977), and the population was considered extirpated by the 1930s. In 1956, WDNR, in cooperation with the U.S. Forest Service, initiated a Fisher reintroduction project, with 60 animals being released in closed areas of the NNF through 1963. Fishers are now common throughout northern Wisconsin, with sightings reported south to near the limits of the continuous forest in Adams, Manitowoc, and Winnebago Counties (Figure 1).

Population analyses by Kohn and Ashbrenner (1992) showed a steadily increasing number of Fishers, from an estimated 2650 in 1977 to 6000 by 1992. Based on model simulations and track-count analysis, Kohn and Ashbrenner assumed a density of one Fisher per 6.5 km^2. Jon Gilbert (personal communication) has documented, by trapping, Fisher densities exceeding one animal per 2.5 km^2 on the Chequamegon National Forest in north-central Wisconsin. During the winter of 1992-1993 the trapping season was liberalized and over 1600 Fishers were taken (R. Eckstein, personal commun cation). The relative frequency of Fisher tracks o the 1992-1993 Winter Furbearer Track Counts wa 4.8, up 25% from the previous winter, and almo double the 2.5 from the 1990-1991 survey (E Kohn, personal communication). This increas occurred despite a ten-fold increased harvest durin 1992-1993. Recent, revised DNR estimates no suggest that 10 000 Fishers were present in 199 (Kohn and Ashbrenner 1993).

Discussion

Prouctivity

Goshawk productivity and nesting densi v been correlated to fluctuations in prey mainly tetranoid populations in northern ...op (Hoglund 1964; Huhtal and Sulkava 1981; Wikma and Linden 1981), and Snowshoe Hares in Alask (McGowan 1975) and the Yukon (Doyle and Smit 1994). Annual productivity in northeaster Wisconsin Goshawks was similar to the value reported in other North American studies and is directly correlated to regional densities of Snowshoe Hares and Ruffed Grouse (Figure 2). In a four-year study by McGowan (1975) in Alaska, the number of young fledged per active nest varied between 1.8 and 2.5. The number of active nests in his study area declined from 9 to 1, with the low occurring in 1974 corresponding to the Wisconsin low during that prey cycle. Overall production in Alaska was 2.0 young fledged per active nest (McGowan 1975). The highest reported annual reproduction in North America was recorded in the Yukon, 3.9 young fledged per active nest in 1990 (Doyle and Smith 1994), 19% higher than we observed in peak years. This high productivity was quickly followed by a decline to 1.3 young fledged per active nest the following year, and no young in 1992. Overall production in their four-year study was 2.3 young fledged per active nest (n = 19) and 3.1 young per successful nest (n = 14).

Doyle and Smith also reported a dramatic decline of active nests exceeding 80%. Active nests in

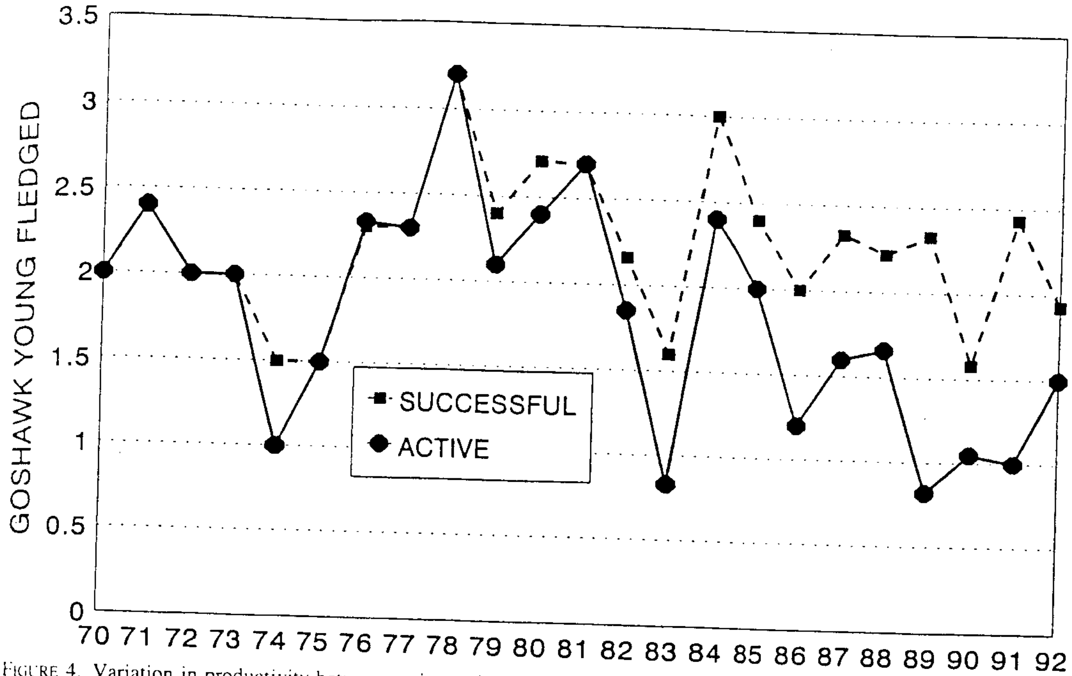


FIGURE 4. Variation in productivity between active and successful nests of Northern Goshawk in northeastern Wisconsin during 1971–1992.

W... have declined by only 50% in each of the two ...st recent cyclic lows, possibly due to the availability of alternate prey species at our more temperate latitude. Wisconsin Snowshoe Hare populations in comparison to Canadian populations have been only "weakly cyclic" since the 1930s, apparently as a result of fire suppression and habitat maturation and fragmentation (Buehler and Keith 1982). The similar wide annual variations in productivity in Alaska, Yukon and Wisconsin appear to be correlated with the dramatic variations in prey density. We suspect, based on the reported severe declines in the numbers of active nests, that the northern populations are much less stabe on a regional scale than the Wisconsin population. Jerry McGowan (personal communication, 1993) noted that neither Snowshoe Hare nor Goshawks ever again reached the high population level or cycled on his 1970s Alaskan study area. The more northern populations are Snowshoe Hare obligates (Keith 1977), and interior Canadian and Alaskan Goshawks exceed Wisconsin birds in both size and mass (Erdman and Brinker, unpublished data). Cyclic declines of Snowshoe Hares in the northern forests have triggered invasions of Goshawks into southern areas (Mueller and Berger 1967; Mueller et al. 1977). In Wisconsin, we have not documented any movement of our marked adult Goshawks out of their breeding range. This 10-year pattern of cycl... ...ductivity has also been documented in Alberta for Red-tailed Hawks, *Buteo jamaicensis* (McInvaille and Keith 1974) and Great Horned Owls, *Bubo virginianus*, in Alberta, Saskatchewan and Manitoba (Rusch et al. 1972; Houston 1978; Adamcik and Keith 1978; Adamcik et al. 1978). This is in contrast to the relatively stable productivity exhibited by Goshawks in the western states. In a six-year Oregon study, Reynolds (1978) reported 2.3 young fledged per successful nest (n = 25) and 1.7 young fledged per active nest (n = 48). This is remarkably similar to 2.1 young fledged per successful nest (n = 135) and 1.6 young fledged per active nest (n = 184) reported in this study (Table 3).

We have observed a significant change in northeastern Wisconsin Goshawk productivity over the 1971-1992 period (Table 3). From 1971 to 1981 nest success was high at 94%. Between 1982 and 1992, the overall nest success in northeastern Wisconsin fell to 62%. The primary cause of the increased nest failure was Fisher predation during incubation.

In northeastern Wisconsin prior to 1985, nest failures were infrequent, and occurred mainly in the southern portion of the study area where Great Horned Owl and Raccoon, *Procyon lotor*, were more abundant. Now more nests are lost in the north, where the dominant predator is the Fisher. Obviously Fishers and Goshawks co-exist over vast expanses of Canada, and historically they did so in Wisconsin. We can find no records in the literature of Fishers taking nesting adult Goshawks in North

America. It is probable that the extensive, continuous, mixed hardwood and conifer forests which existed prior to settlement, provided more concealed (optimal) sites which protected the nests from destruction. Current forests are often composed of monotypic stands of Aspen, Paper Birch, and pine: the two former species in particular providing more exposed nest sites. An example of the effect of loss of nest cover occurred in 1989, when 66% of the Goshawk nests were lost when Forest Tent Caterpillars defoliated deciduous trees. During that same year, 18 of 19 Red-shouldered Hawk nests were also lost to predation. Another possible factor leading to increased predation is the concentration of both Fishers and hawks in the same habitat due to forest fragmentation, created by the clear-cutting of large tracts. Carcasses and gut piles left by hunters of Wisconsin's estimated 1.5 million White-tailed Deer, *Odocoileus virginianus*, also provide Fisher with excellent overwinter survival rates.

Population Model and Trend Analysis

In 1979, to estimate yearly changes in the population and evaluate long term trends, we developed a population model for northeastern Wisconsin Goshawks (presented at 1980 American Ornithologist's Union meeting, Fort Collins, Colorado). The model assumed a population with all adults, at least 24 months old and 10% of one-year- old birds attempting to breed, with a nesting success rate of 75%. In northeastern Wisconsin the proportion of one-year-old females breeding in any given year has never exceeded 20%. Most one-year-old males are apparently incapable of breeding (Cramp and Simmons 1980; Glutz et al. 1971) and we have never encountered males entering the breeding pool before the age of 24 months. The 10% (above) was calculated as a proportion of the juveniles surviving from the previous year. We assumed 65% first-year mortality and an equal sex ratio. Adult mortality was assumed to be 20% annually. The adult mortality rate was based on turnover rates of adults in established territories as measured from our recapture and band recovery data. The model required 1.7 young to be fledged per nesting pair to maintain a stable population, a value very similar to the overall mean number of young fledged per active nest in northeastern Wisconsin. Population trends were simulated by using the observed annual productivity and nest success as measured in our study area for 1971 through 1992 (Figure 5).

The model showed increasing Goshawk populations from 1971 through 1986. The simulated population doubled by 1981, then declined by 34% during the periodic low of the 10-year population cycle in 1983, but was able to recover by 1985. Since then a gradual decline has decreased population values to the initial 1971 level in 1991.

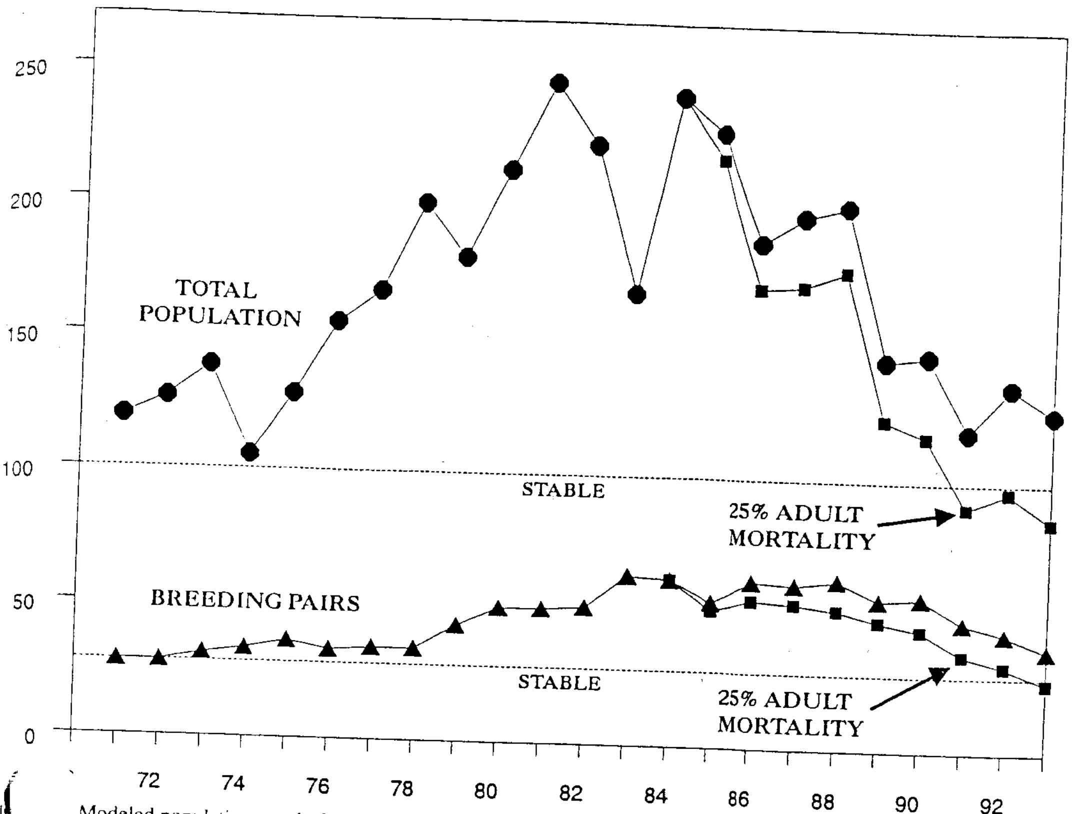
Increasing the adult mortality to 2[illegible] ec an additional 5% loss to Fisher for al[illegible] [illegible]s [illegible] 1984, we observe an overall population declin 14% below the 1971 level (Figure 5). The nun of breeding pairs mirrored this pattern, with expected two-year time lag for juveniles to m into the breeding population.

The results of our population simulation ag with this general impression of an increasing popu tion expanding southward between 1971 and 19 A similar trend has been noted in the lower penin la of Michigan (Sergej Postupalsky, personal co munication; Brewer et al. 1991). These increa could reflect improving habitat conditions as reg erating northern forests mature. The signific changes in reproductive success that occurred duri the late 1980s are cause for serious concern. T changes in reproductive success reversed the trend the model population and produced a steeper decli from 1986 to 1992 than the 1971 to 1985 increase.

The observed increase of the adult fema turnover rate to 40% since 1987 which we attribu to mortality, is the most important paramet impacting the population. Recapture and recove data, prior to the Fisher predation, indicated th adult male Goshawks were surviving approximate 25% longer than adult females. If, indeed, femal have a shorter life span, the increased female bi predation will only result in an unbalanced sex rati with an inevitable decline in Goshawk nu[illegible] W are now recording previously active [illegible]rie where only males are present. It should [illegible]ote that Fishers are highly territorial and vigorousl recheck previous kill sites each time they pas through the area (Jon Gilbert, personal communica tion). If a male Goshawk, who has lost his mate to predation, attracts a new female to the territory and she reuses an existing nest platform that was previously predated by a Fisher, she also faces a high probability of nest failure and death. This recent phenomenon of nest failure and increased adult mortality has not been noted in the lower peninsula of Michigan where Fisher are absent and Goshawks continue to expand southward (Postupalsky 1993, and personal communication).

Territory Longevity

In northern Wisconsin current forest management practices have often adversely affected Goshawks and other woodland nesting raptors such as the state threatened Red-shouldered Hawk. It has been our experience that large clearcuts typical of county and some commercial forests allow Red-tailed Hawks and Great Horned Owls to move into an area and displace the woodland hawks. We have witnessed owl predation on Goshawk nestlings, fledged young and adults. This pattern of displacement by owls in relation to forest ownership and logging is apparent in Table 1. Selective cuts adjacent to clearcuts or



Fi Modeled population trend of Northern Goshawks in northeastern Wisconsin from 1971-1992.

natural openings that open the canopy over 40% have the same effect. NNF, which has had the least percentage of territories occupied by owls (8%), has a moratorium on any clearcuts exceeding 16 ha in size. The different average rotation period of Aspen-Birch stands on NNF, 40-60 years, and county forest, 30-45 years, results in earlier logging of Goshawk nest sites on county forest land. The shorter rotations used on county forest lands effectively limits the "window of opportunity" for Goshawks attempting to utilize maturing Aspen-Birch stands as nest sites (Table 1). The effect of forest management is apparent in Goshawk territory longevity (Table 2). Territories have seldom persisted over five years on county forest lands while a site on NNF, where management practices are markedly different, has lasted over twenty five years. The highest mean territory longevity (10.2 years) occurred on state owned lands. Two of these territories were located in large forested state parks where no logging occurred. Notably, average territory longevity in Wisconsin was 3.9 years with a range of 1 to 26 years. Speiser (1991), reported an average occupancy of 3.83 years with a range of 1 to 8 years in New Jersey and New York.

Status and Conservation Needs

Our main concern for the Wisconsin Goshawk population is the lack of a statewide forest management plan with mandatory nest site protection guidelines for woodland raptors. NNF is the only Great Lakes States national forest to have established and implemented nest management guidelines for Goshawks and Red-shouldered Hawks. These guidelines require road closure and a 8 ha buffer around a nest. Only limited selective cutting is allowed around the buffer. NNF also has a moratorium on any clearcuts exceeding 16 ha in size and the cutting of White Cedar, *Thuja occidentalis*, and Eastern Hemlock is also prohibited. These guidelines, established in 1986, have yet to be evaluated. However, currently 70% of our active territories are on NNF. Effective evaluation will be complicated by the problem of increased Fisher predation.

Another negative pressure on the population is the legal and illegal "take" of nestling Goshawks by falconers. Over the 22-year period of our study the effect of falconers removing young has reduced the mean reproductive success by one tenth (Table 3). Unfortunately, due to poor state regulation and inadequate state and federal record keeping, it is almost impossible to determine the number of Goshawks harvested annually.

It is very difficult to assess the population status of Goshawks in Wisconsin in terms of abundance and density. Territories are widely dispersed, nonrandomly, and undergo fluctuations of up to 50% through the 10-year prey cycle. Current forestry often produces rapid habitat changes. Recent increases in adult mortality and decreases in productivity are of concern and need to be further monitored. Landscape scale management of Wisconsin's forests is needed to provide for the habitat needs of Goshawks.

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