

TERRITORY FIDELITY, MATE FIDELITY, AND MOVEMENTS OF COLOR-MARKED NORTHERN GOSHAWKS IN THE SOUTHERN CASCADES OF CALIFORNIA

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Abstract. Eighty adult Northern Goshawks (*Accipiter gentilis*) were marked with color bands during a 9-year period in northern California, and 119 nestlings were banded. Observations in subsequent years located 47% of the adult females and 40% of the adult males. Seventy-two percent of the adults located in consecutive years retained the mate from the previous year. There was no significant difference in mate retention among sexes. Males were significantly more likely to remain in the same territory from year to year than were females. Among hawks located in years subsequent to marking, 18.2% of the females and 23.1% of the males were found breeding in other territories 4–13 km from the location of marking. Two banded nestlings (1.7%) were recaptured as adult female breeders at distances of 16 and 24 km from their natal sites.

Key Words: *Accipiter gentilis*; color-marking; movements; Northern Goshawk; site and mate fidelity.

Since 1983, Northern Goshawks (*Accipiter gentilis*) have been marked on three USDA Forest Service ranger districts (RD) in northern California: the McCloud RD on the Shasta–Trinity National Forest (1983–1989), the Gooseneck RD on the Klamath National Forest (1985–1993), and the Devil's Garden RD on the Modoc National Forest (1988–1992). The objectives of this marking were to evaluate mate fidelity and site fidelity, turnover of adults at territories, and movements among territories.

METHODS

Adult Northern Goshawks were captured at nest sites using the dho-gaza with a live Great Horned Owl (*Bubo virginianus*) as a lure (Bloom 1987, Bloom et al. 1992). Adult goshawks were banded with U.S. Fish and Wildlife Service (USFWS) aluminum bands on one leg, and with colored plastic bands with contrasting numerals on the other leg. Goshawks were identified in subsequent years either by re-trapping or by reading color bands with binoculars or spotting scope. The degree of annual follow-up effort varied considerably because of variation in personnel and funding. Typically, each year several hours were spent during the nestling period searching for nests and hawks in each area where nesting had been recorded in the past. In later years, taped goshawk calls were used to locate nests. On the Gooseneck RD, standardized belt transects were employed to locate sites, and blinds were built to facilitate reading color bands. Climbers banded nestling goshawks with USFWS bands; nestlings were not marked with color bands. Most nests were climbed while the adult female was held hooded.

We did not reliably locate marked goshawks that did not nest or that failed during incubation, because early in the nesting season access was limited by snow and the goshawks were secretive. Because we were most successful in finding nests and trapping and identifying adults during the nestling period, this study was limited primarily to goshawks that were successful in hatching young.

We used the term "occupancy" to include any year in which a marked adult was found in a territory (including the year of marking). Goshawks that had not yet ended a period of occupancy were not included in calculations of duration of occupancy. We used the term "fidelity" to refer to consecutive years of occupancy or mate retention by marked individuals. A territory was defined as a cluster of nest sites with >1 year of recorded use (Woodbridge and Detrich *this volume*). Occasionally, marked adults were located in a territory even though the nest was not found. Because these adults demonstrated site fidelity, they were included in the analysis. Significance of proportional differences in fidelity to mate and site were analyzed using the log-likelihood ratio (Zar 1984:52).

RESULTS AND DISCUSSION

Through the 1991 season, we color-banded 47 adult females and 33 adult males, and banded 119 nestlings. Results include re-sightings through the 1992 season. Twenty-two females and 13 males were found in years following marking. Thus, 53% of the females and 60% of the males either died or were not found in subsequent years. Two goshawks banded as nestlings were located as breeders in subsequent years. One marked goshawk was found dead. At least one adult was marked in 46 territories. We attempted to locate marked birds in 194 territory-years (i.e., a year subsequent to marking during which searches or observations took place in the territory). Marked females were located in 98 (51%) of these opportunities, and marked males were located in 60 (31%).

OCCUPANCY AND FIDELITY TO MATES AND NEST TERRITORY

Territory occupancy by females ranged from 1 to 7 years, and averaged 1.8 years (SD = 1.3, N = 40). Because of the difficulty of finding nests

TABLE 1. SITE AND MATE FIDELITY AMONG MARKED REPRODUCTIVELY SUCCESSFUL NORTHERN GOSHAWKS IN SUCCESSIVE YEARS IN NORTHERN CALIFORNIA

Pattern	% males (N)	% females (N)	Overall (N)
Same mate	75.0 (12)	69.2 (13)	72.0 (25)
Same nest area	76.5 (17)*	71.4 (49)	73.1 (66)

* Significant difference between sexes ($G = 5.2$, $df = 1$, $P < 0.025$).

in consecutive years (Woodbridge and Detrich *this volume*), the observed mean occupancy was probably less than the actual.

Territory occupancy by males ranged from 1 to 3 years, and averaged 1.3 years ($SD = 0.54$, $N = 27$). The observed occupancy by males was also believed to be lower than the actual rate and cannot be directly compared with that of females because of the greater difficulty in trapping and observing males.

In 18 of 25 instances when mates were identified in consecutive years, the mate from the previous year was retained (Table 1). Mate retention did not differ significantly between sexes ($G = 0.8$, $df = 1$, $P < 0.40$). In 48 of the 66 instances in which adults in a territory were identified in consecutive years, marked adults remained in the territory. Males were significantly more likely to remain in the same territory from year to year than were females ($G = 5.2$, $df = 1$, $P < 0.025$).

Among the 23 adults that remained on the same territory in consecutive years and whose mate was known in those years (Table 2), there was no significant difference in mate retention between sexes ($G = 3.6$, $df = 1$) at $P < 0.05$, but at $P < 0.10$, males were more likely to retain the same mates than were females, suggesting a tendency in this regard.

Considerable variation was observed among adults that did not retain mates in consecutive years. For instance, in three territories observed for five-year periods, two males and two females bred in three different combinations. Another male bred with three different females in the same territory during a six-year period; one of these females was present in three non-consecutive years.

We remain uncertain as to the effects of our activities on site occupancy and fidelity. Among 17 occupied nests where no trapping or banding occurred, only two were occupied in the following year, indicating a high degree of movement in the undisturbed population. However, because these adults were not marked, fidelity patterns in the undisturbed population could not be determined for comparison.

TABLE 2. MATE FIDELITY AMONG MARKED REPRODUCTIVELY SUCCESSFUL NORTHERN GOSHAWKS IN SUCCESSIVE YEARS IN THE SAME BREEDING TERRITORY IN NORTHERN CALIFORNIA

Pattern	% males (N)	% females (N)	Overall (N)
Same mate	80.0 (10)	69.2 (13)	73.9 (23)
Different mate	20.0	30.8	26.1

MOVEMENTS

Among the 22 females located in years subsequent to marking, four (18.2%) were found breeding at a second territory. These movements ranged from 5.5 to 12.9 km (mean = 9.8 km, $SD = 2.7$). One of these females later returned to the territory where she had been marked; that territory had been occupied by another female during the interim. Among the 13 males located in years subsequent to marking, three (23.1%) were found breeding at a second territory. Their movements ranged from 4.2 to 10.3 km (mean = 6.5 km, $SD = 2.7$).

The distances to the nearest neighboring territory for most of the adults that moved were not reliably known. However, nearest-neighbor distances in intensively surveyed portions of the study area ranged from 1.3 to 6.1 km (mean = 3.3 km, $SD = 0.3$) (Woodbridge and Detrich *this volume*). All adult movements among territories were more than two standard deviations greater than the mean nearest-neighbor distance, and thus, it appears that few were likely to involve movements to neighboring territories.

Two of the 119 nestlings banded (1.7%) were recaptured as adult female breeders at distances of 16.1 and 24.2 km from their natal sites. One was captured in the fifth year following banding, the other in the seventh year following banding.

TURNOVER IN TERRITORIES

Analysis of turnover was problematic because of the high rate of attrition of territories (Woodbridge and Detrich *this volume*), movement among territories by both sexes, intermittent use of territories by individuals, and the need for more years for observations of hawks marked in recent years.

In 27 territories occupied in the year following marking of adults, eight (30%) were occupied by new females and six (23%) were occupied by new males. Among the 43 territories with marked females, 16 were occupied by different females during different years. One was occupied by three different females in a 6-year period, and another by four different females in an 8-year period.

Among the 34 territories with marked males, 13 were occupied by different males in different years; one was occupied by three males in an 8-year period.

To our knowledge, there are no published data on Northern Goshawks for comparison with the results of this study. Our data indicate that some previous assumptions about mate fidelity need re-examination, for instance statements by Jones (1979) and Palmer (1988) that goshawks probably mate for life.

Site fidelity reported for the congeneric European Sparrowhawk (*Accipiter nisus*) (Newton and Wyllie 1992) was similar to that found in our study in that about 70–75% of hawks found in successive years were on the same territory. Northern Goshawks on our study area retained mates more frequently than European Sparrowhawks (Newton and Marquiss 1982), which might be partially explained by a presumably higher mortality rate among the smaller sparrowhawks. Movements by male sparrowhawks were often to a neighboring territory, whereas females typically moved further (Newton and Wyllie 1992).

Our data provide only a partial understanding of tendencies and variation within the population studied, despite a substantial sustained effort in the field. Our experience indicates that obtaining complete demographic data for Northern Goshawks will demand efforts far exceeding those expended in the last 10 years on the Northern Spotted Owl (*Strix occidentalis caurina*) (Thomas et al. 1990). Researchers contemplating marking studies of Northern Goshawks must be committed to intensive long-term efforts to obtain adequate data.

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