State of California
THE RESOURCES AGENCY
Department of Fish and Game

THE STATUS OF THE NORTHERN GOSHAWK IN CALIFORNIA, 1981-1983

Photo by Peter H. Bloom

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Wildlife Management Branch
Administrative Report 85-1

STATE OF CALIFORNIA—THE RESOURCES AGENCY

GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF FISH AND GAME
1416 NINTH STREET
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To Whom It May Concern:

"The Status of the Northern Goshawk in California, 1981-1983," represents the current level of knowledge regarding the Northern Goshawk (Accipiter gentilis) in the State. The conclusions and recommendations in the report represent the opinions of the authors. Our hope is that the information will lead to much needed additional research, and to federal and state management decisions aimed at guaranteeing the long-term viability of Northern Goshawk populations. The extensive combined experience of the authors and their intuition in matters related to raptor biology must, for now, compensate for any gaps in scientific data. For this reason, the report's recommendations should set the stage for a coordinated state, federal, and private effort to ensure this species future in California.

Sincerely,

Jack C. Parnell
Director

Enclosure

THE STATUS OF THE NORTHERN GOSHAWK IN CALIFORNIA, 1981-1983[1/]

by

Peter H. Bloom, Glenn R. Stewart
and Brian J. Walton[2/]

ABSTRACT

A study to determine the status of the Northern Goshawk in California was conducted during the summers of 1981-83. Status determination was accomplished by comparing the species' current and historic distribution and abundance. We also performed a cursory examination of Northern Goshawk reproductive performance, food habits and habitat utilization.

The results of this investigation suggest that there are approximately 1,300 Northern Goshawk nesting territories in the state, of which about 805 (61%) are active each year. Approximately 733 (91%) of these active nests fledge at least one young. Statewide, the species seems to be reproductively healthy. On a regional basis, however, Northern Goshawks are doing relatively poorly in the Northern Coast Ranges-Klamath Mountains and on the east side of the Sierra Nevada.

Most territories in this study were located previously by timber cruisers and cutting crews. Timber harvesting is the most important factor affecting Northern Goshawk populations in California, with some territories having been abandoned just prior to or during this study. Approximately 5-10 territories are thought to be lost each year. Climatic variability is also an important factor in goshawk survival, particularly in the Sierra Nevada. The severe weather in spring 1982 and 1983 was probably responsible for low occupancy in some regions in those years of this study. The effect of falconry on Northern Goshawks in California is negligible statewide but may be important in local areas or at specific territories.

Management recommendations include temporarily restricting falconry harvests in parts of the eastern Sierra Nevada and managing for a viable nesting population on all the National Forest and other public and private lands in California.

1/ Wildlife Management Branch Administrative Report 85-1. Supported by Federal Aid in Wildlife Management, Nongame Wildlife Investigations, California Department of Fish and Game, W-64-R-2.

2/ Peter H. Bloom, Glenn R. Stewart and Brian J. Walton. Predatory Bird Research Group, Lower Quarry, University of California, Santa Cruz, CA 95064.

RECOMMENDATIONS

1. The U.S. Forest Service and the California Department of Fish and Game should determine the effect of timber harvesting on Northern Goshawk territories and the amount of habitat required to ensure a viable goshawk population.

2. The U.S. Forest Service should increase the stand size of timber preserved within nesting territories from 10-32 ha (25-80 acres) to a minimum of 50 ha (125 acres) until research findings can more fully document the habitat needs of the Northern Goshawk.

3. The U.S. Forest Service should increase the total number of breeding pairs of Northern Goshawks to be managed on National Forest lands in California.

4. The California Fish and Game Commission and the California Department of Fish and Game should temporarily prohibit the take of Northern Goshawks for falconry in the Sierra Nevada from the Sierra Crest east to the Nevada border in Mono and Inyo counties until the factors affecting this population are more clearly understood.

INTRODUCTION

A study of the Northern Goshawk (Accipiter gentilis) was conducted during the summers of 1981-83, in response to recommendations contained in the California Department of Fish and Game's (CDFG) "A Plan for California Raptors" (Mallette and Schlorff 1978) and in "Bird Species of Special Concern in California" (Remsen 1978). The Northern Goshawk was identified in the reports as a species which warranted detailed study because of threats to it posed by habitat destruction and human disturbance. This study was undertaken to determine the status, distribution, population size and some of the ecological needs of the species.

The Northern Goshawk is one of the least studied diurnal raptors in California. Despite its relatively large size, aggressive nature, and extensive breeding range in the mountainous regions of the state, few details on range and population size are available. Although a number of studies and notes have been published (Ray 1926; Ingles 1945; Dixon and Dixon 1983), most are of limited scope and none provide information on the statewide population status.

The habitat studies conducted by Saunders (1982) and Hall (1984) are very complete and add significant, much needed information on Northern Goshawk nesting habitat in northern California. Schnell (1958) conducted an excellent investigation of nesting behavior and food habits. However, much more research on all aspects of goshawk ecology needs to be done.

In this study, we have attempted to pool all of the information on Northern Goshawks from published sources in California and from several unpublished records. It is hoped that this study will identify those aspects of goshawk ecology that are the least known or little studied and that it will stimulate future research.

STUDY AREA

Historical and recent records of nesting Northern Goshawks in California indicate that the species nests only in the montane coniferous forests of the state. Therefore, the study area included all upper elevation coniferous forest habitats above the pinyon pine-juniper plant association in the Sierra Nevada, Klamath, Cascade, Warner and White mountain ranges. The lower elevation coniferous forest habitats along the northwest coast of California also were included.

The state was divided into several geographic regions so that different subpopulations could be addressed individually (Fig. 1; Table 1). Within these regions, research emphasis was placed on the Mount Shasta (Saunders 1982), Warner Mountains, Modoc Plateau and Mammoth Lake vicinities because previous research efforts in these regions established a good foundation for further work.

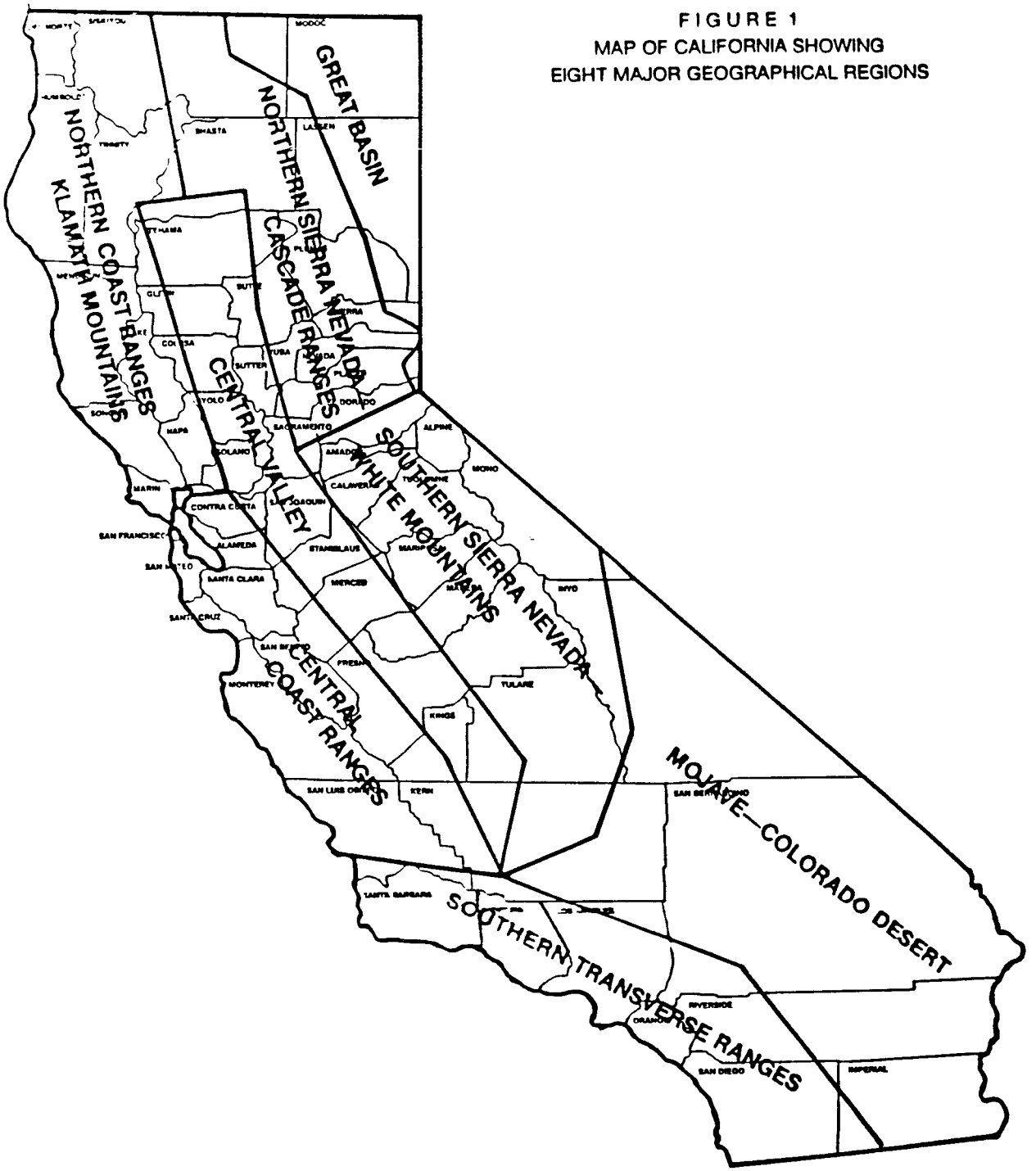


FIGURE 1
MAP OF CALIFORNIA SHOWING
EIGHT MAJOR GEOGRAPHICAL REGIONS

METHODS

Given the extensive range of the species, and its preference for montane, coniferous forests, the Northern Goshawk is a difficult species to study. For this reason, we relied largely upon the observations of field biologists to provide locations of nest sites. In order to locate as many nesting territories as possible, data on recent observations of nesting Northern Goshawks were requested from the U.S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service (NPS) and from falconers. The majority of nest site locations were provided by USFS biologists. Data on historical nest locations were obtained from the Western Foundation of Vertebrate Zoology (WFVZ), Museum of Vertebrate Zoology (MVZ), Santa Barbara Museum of Natural History (SBMNH) and literature. The raptor bibliography of Olendorff and Olendorff (1968-70) and Shuster (1977) were used extensively during the literature search. Although 18 historic (1904-69) and 111 recent (1970-80) nest territories were reported to us, most of our survey emphasis was placed on 114 territories that were reported as currently active (1981-83). When time allowed, we checked historic and recently active sites. Considerable time also was expended surveying for new territories throughout the species' range.

During 1981, major emphasis was placed on gathering preliminary data needed to meet the major objectives of determining status, distribution and abundance. Contacts were made with persons knowledgeable about goshawk nest territories, and an extensive literature search was begun. In addition, some reproductive and food habits data were collected. In 1982 and 1983, we collected data from all nest territories checked in 1981 and 1982 and searched for or verified new territories.

Fieldwork in 1981, 1982 and 1983 was conducted from June 22 - August 2, June 20 - July 22 and June 13 - August 5, respectively. The number of biologists working in the field on the project were one in 1981, two in 1982 and four in 1983. In addition at least one USFS biologist accompanied us in the field on most days. The amount of time any one biologist spent in the field per year ranged from two to six weeks. Biologists from the Santa Cruz Predatory Bird Research Group working directly on the project over the three-year period expended 155 field days.

Within each region, population estimates for 1981-83 were derived by the following method. "Sample tracts" represented by contiguous terrain, were given intensive scrutiny by previous researchers or during this study. We used one or two sample tracts per region. In regions where there were large monotypic areas of habitat such sample tracts were considered to be representative of the region as a whole. It was, therefore, possible to extrapolate goshawk breeding densities from survey tract to region. The number of nesting territories per township were multiplied by the number of townships with suitable habitat to obtain each regional estimate. This technique significantly expedited the reconnaissance of this enormous study area. Similar methods of estimating statewide raptor populations have been used by Oakleaf (1975) on Northern Goshawks in Nevada and by Bloom (1980) on Swainson's Hawks (Buteo swainsoni) in California.

Problems inherent in estimating California's goshawk population include: (1) the habitat characteristics derived from our sample area were not necessarily representative of the whole region, particularly in areas of intensive timber management where the available habitat had a more unpredictable distribution, and (2) the vastness of the study area precluded intensive survey work of most townships. For these reasons, we recommend that our regional and state estimates be regarded as approximations.

Food habits and reproductive data were obtained by climbing nest trees, identifying and/or collecting prey remains and counting the number of eggs and nestlings. Nestlings older than two weeks were banded. Nests were examined one to two times per season.

Whenever possible, adults were trapped to obtain information on territory and mate fidelity, mortality factors and migration. A live Great Horned Owl (Bubo virginianus) decoy and a mist net were used to trap adult goshawks (Hamerstrom 1963).

RESULTS

Historical Distribution and Abundance

Historical documentation of Northern Goshawk nesting territories is minimal in California. Only 18 territories were identified through literature searches and oological records.

The known historical breeding range appears smaller than the current (1981-83) distribution (Fig. 2). This is due to the current surge in interest in the species in western North America (Reynolds and Wight 1978; Saunders 1982; Moore and Henny 1983; Hall 1984), rather than an actual expansion in the species' range.

Most records (16) came from the southern Sierra Nevada-White Mountains region while one record each came from the northern Sierra Nevada-Cascade, and southern Transverse Range regions. Records for the Mojave-Colorado Desert, Northern Coast Ranges-Klamath Mountains, Central Coast Range, Great Basin and Central Valley regions are completely lacking. No territories were ever recorded in the Mojave-Colorado Desert, Central Coast Range and Central Valley where habitat is limiting, and no documentation exists for the Northern Coast Ranges-Klamath Mountains and Great Basin. Both of the latter two regions historically contained significant amounts of old growth coniferous forest habitat, a favored environment for goshawks. In all probability, the historical distribution of the Northern Goshawk in California was virtually the same as that reported in the current study.

An unusual historical nest record exists from Ventura County which represents the southernmost known nesting attempt by Northern Goshawks in California. However, several spring-summer observations of adult birds in the San Bernardino, San Jacinto, San Gabriel and Clark Mountains (Garrett and Dunn 1981) suggest a strong possibility of nesting attempts further south.

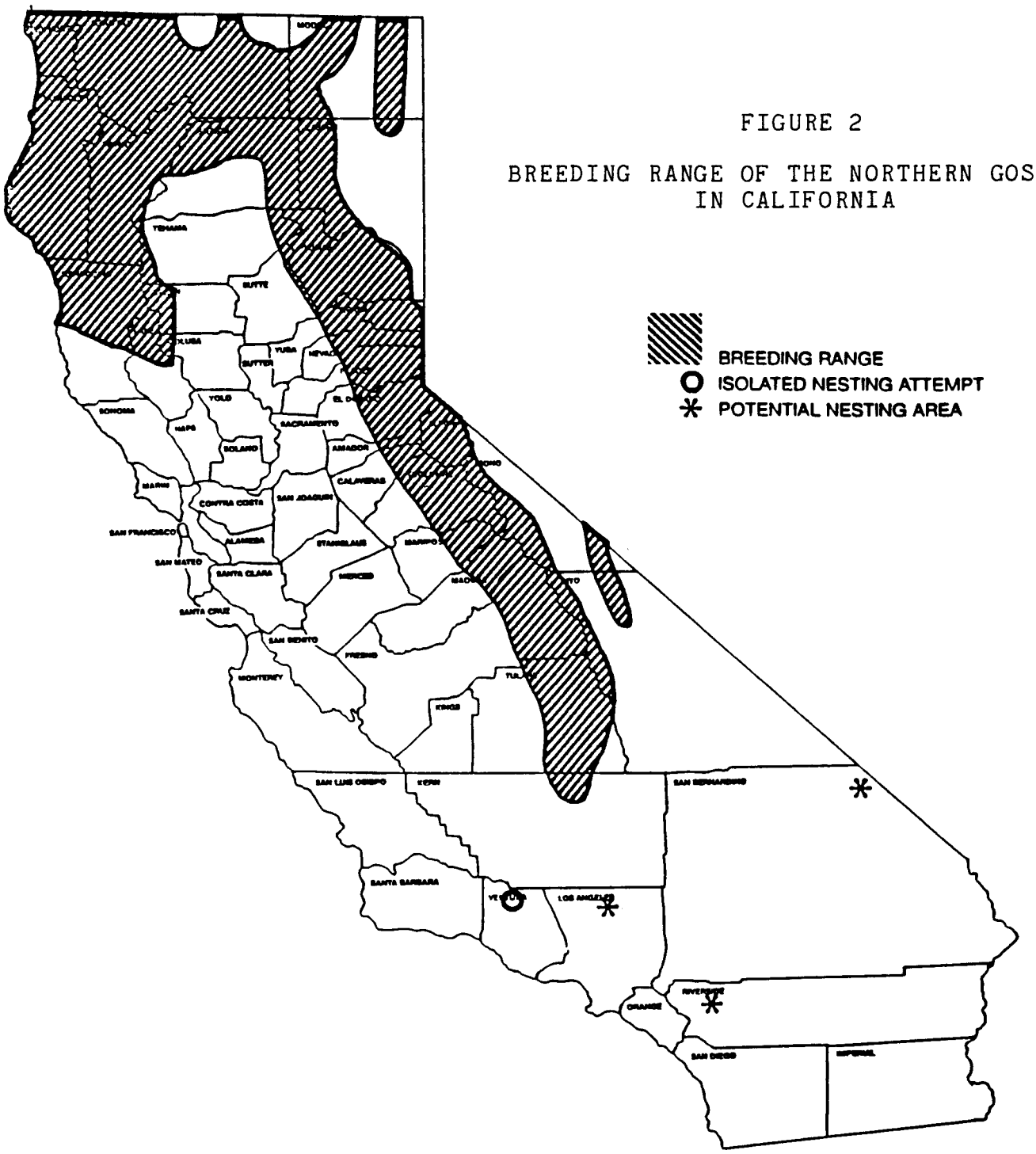
Table 1. Breeding Territories of Northern Goshawks in California[1/]

Region	Historically (1904-1969) Active Breeding Territories	Recently (1970-1980) Active Breeding Territories	Currently Active (1981-1983) Breeding Territories	Total Estimated Breeding Territories
Southern Transverse Range	1	0	0	5
Mojave-Colorado Desert	0	0	0	5
Northern Coast Range-Klamath Mountains	0	10	20	275
Central Coast Ranges	0	0	0	0
Southern Sierra Nevada-White Mountains	16	17	34	515
Northern Sierra Nevada-Cascade Ranges	1	22	30	425
Great Basin	0	61	30	95
Central Valley	0	0	0	0
TOTAL	18	110	114	1,320

1/ Historical data were obtained from the literature and oological collections. Recent data were obtained primarily from the USFS and current data were obtained primarily from the USFS and this study. The larger number of currently active territories found in most regions reflects the effort applied during this study and not an increase in the species' population size.

FIGURE 2

BREEDING RANGE OF THE NORTHERN GOSHAWK
IN CALIFORNIA



The goshawk always has been regarded as rare in California. As an indication of its rarity in Mono County, Dixon and Dixon (1938) stated that "in the eight year period we have only seen three Western Goshawks other than the pair covered by this article." Similarly, Moffit, in an article by Ray (1926), described the species as "very scarce" in the Tahoe area. Goshawks were probably much more common historically than early observers realized. However, because few intensive ecological studies were conducted, species with a common and predictable distribution received little attention.

Apparently the goshawk was once a more frequent migrant to southern California. Colburn (1917) reported three Goshawks taken in the Los Angeles area in 1916 and four goshawks were taken the same year in Ventura County (Peyton, 1917). Similarly, an adult goshawk was collected in Imperial County (Grinnell 1917). Surprisingly, Dixon and Dixon (1938) described the species as "a common winter visitant" in San Diego County. The occurrence of wintering goshawks in Los Angeles, Ventura, San Diego and Imperial counties is a phenomenon that is no longer witnessed in these southern locales. At best an occasional individual is seen in any one year.

Since no quantitative studies of nesting densities or estimates of populations were attempted historically, it is difficult today to make an estimate of the historical size of the state population. However, we estimate that the historical population was most likely 25% to 50% larger than at present. The estimated loss is attributed to habitat rendered unsuitable, primarily as a result of logging activity throughout the species' range. We base this assumption on the fact that much of the state's harvestable timber has already been cut one to two times and that most of it is either in young transition stages or is no longer suitable habitat for nesting goshawks.

Current Distribution and Abundance

During this study, we collected data on 114 current nesting territories. The vast majority of nest site locations were provided by biologists of the USFS (exact nest locations have been excluded from this report to protect them from possible harassment). Nesting activity was recorded in the southern Sierra Nevada-White Mountains, northern Sierra Nevada-Cascade Ranges, Great Basin, and Northern Coast Ranges-Klamath Mountains regions.

Historical and recent reports of nesting goshawks in the Northern Coast Ranges-Klamath Mountains are meager compared with the other three principal regions of the state. Although no areas in the Northern Coast Ranges-Klamath Mountains region were surveyed intensively, our overall impression is that the population is small. Territories seem few and far between, but whether this is due to the limited surveys conducted in that area or to local extirpation due to logging in the regions is unknown.

In regions which showed considerable heterogeneity in habitat characteristics or which lacked any prior intensive survey work, population estimation was more difficult and as a result is probably less reliable. In particular, it

should be noted that the Northern Coast Ranges-Klamath Mountains region lacked a discrete survey tract (although 20 isolated territories were reported). Large heterogeneous portions within regions in other parts of the breeding range such as the west slopes of the Sierra Nevada also lacked survey tracts. Both the west slopes of the Sierra Nevada and Northern Coast Ranges-Klamath Mountains region represent relatively different habitats compared to the Great Basin, Northern Sierra Nevada-Cascade Range and Eastern Sierra Nevada regions.

McGowen (1975) found approximately two active goshawk territories per township in Alaska but suggested that the actual number may have been higher because of nests that were overlooked. Our sampling areas provided estimates of one nesting territory per township (93 square km) in poor habitat to three nesting territories per township in optimum habitat in all regions. The number of nesting territories per township multiplied by the number of townships with suitable habitat in each region resulted in a statewide estimate of approximately 1,300 nesting territories. However, as noted in the reproduction section of this report, we estimated that only 61% of the territories are active each year.

We have provided regional estimates of the number of goshawk breeding territories, and the number of townships with suitable nesting habitat (Table 2) that our estimates were based upon, so that future investigators can more easily examine our population estimate. Areas needing intensive surveys include the northwestern forests and the west slope forests of the Sierra Nevada.

Gross population estimates, while not precise, are valuable for making comparisons with other populations or species. Oakleaf (1975) estimated 500 goshawk nesting territories in the state of Nevada. Raptor population estimates recently completed in California include 500 breeding pairs of Golden Eagles (Aquila chrysaetos) (Thelander 1974), 67 pairs of Bald Eagles (Haliaeetus leucocephalus), 375 pairs of Swainson's Hawks (Bloom 1980), 64 pairs of Peregrine Falcons (Falco peregrinus) (R. Jurek, pers. comm.) and five pairs of California Condors (Gymnogyps californianus) (N. Snyder pers. comm.). More numerous species such as the American Kestrel (F. sparverius) and Red-tailed Hawk (B. jamaicensis) number in the tens of thousands of breeding pairs.

Breeding Biology

We analyzed reproductive data from 1981-83 (Table 3). Nests were defined as active if they were rebuilt or showed signs of use such as the presence of an incubating adult, eggs or young. A nest was considered successful if at least one young was fledged. Most of the nests found between 1981 and 1983 were examined by one of the authors. Differences in the experience of the USFS biologists who cooperated with us in this study may have introduced some bias into the fledging or mortality data. Most observations recorded by cooperators were made from the ground while most of our data were collected by climbing the nest tree. As a result of these different methodologies, some of the reproductive data may not be directly comparable. All data collected are

Table 2. Regional Estimates of the Number of Townships With Northern Goshawk Nest Territories

REGION	No. of Townships with less than 2 territories	No. of Townships with 2 territories	No. of Townships with 3 territories
Southern Sierra Nevada-White Mountains	215	45	70
Northern Sierra Nevada-Cascade Range	75	130	30
Northern Coast Ranges-Klamath Mountains	205	-	-
Great Basin	20	-	25
Southern Transverse Ranges	5	-	-
Mojave Colorado Desert	5	-	-

Table 3. Northern Goshawk Reproduction in California 1/

	Av. No. Young fledged/ active nest	No. and (%) of nests successful	Total No. and (%) active	No. and (%) active 1981	No. and (%) active 1982	No. and (%) active 1983
Great Basin	1.61 N=41 2/	40(82)	50(72)	13(93)	17(71)	20(65)
Southern Sierra Nevada-White Mountains	1.77 N=22	40(98)	41(49)	21(86)	12(40)	8(27)
Northern Sierra Nevada Cascade Ranges	1.72 N=50	65(93)	69(70)	31(89)	14(54)	24(63)
Northern Coast Ranges	1.86 N=14	19(90)	21(48)	14(67)	2(18)	5(42)
California Total	1.71 N=127	164(91)	181(61)	79(84)	45(49)	57(52)

1/ Collected from 114 nesting territories

2/ Sample size

included here, however, to provide some general insight into the species' reproductive performance. It should also be noted that while cooperator experience was variable, all results reported here compare very closely with those obtained by Reynolds and Wight (1978) in an intensively studied area in Oregon.

The proportion of goshawk territories that were active each year in each of the four principal regions (Great Basin, Northern Coast Ranges-Klamath Mountains, Northern Sierra Nevada-Cascades Ranges, Southern Sierra Nevada-White Mountains) was extremely variable. Sixty-one percent of the territories in the four regions contained active nests, a figure which is similar to that reported by Oakleaf (1975) in Nevada, in which 66% of the territories studied were active. Linden and Wikman (1983) found the proportion of breeding pairs active in Finland to be low also, varying from 48% to 56% during the years 1977-79.

The Southern Sierra Nevada-White Mountains region showed the greatest annual variability in percent active nests. It varied between 86% in 1981 and 27% in 1983. We suspect that this variability is due to the extremely harsh winters that occasionally occur in these mountains. The east side of this region (east of the Sierra crest) showed the lowest percent activity with only 14% of 21 territories active in 1983 and 29% of 24 territories active in 1982. Decreased breeding activity in goshawks as a result of inclement weather has also been suggested by Huhtala and Sulkava (1981) and by Oakleaf (1975). In some parts of the eastern Sierra Nevada which range up to 4400 m (14,436 ft.), the snow was over 6 m (19.7 ft.) deep and actually covered nests in the spring of 1982 and 1983 (D. Asher, pers. comm.).

The quantity of food supply also is known to influence the number of active nesting territories. In Finland, Wikman and Linden (1981) reported that the number of active territories in their study area varied between 28 in 1974 and nine in 1981. The gradual decline coincided with reduced grouse numbers. McGowan (1975) found a similar relationship between goshawk and rabbit numbers in Alaska. In the Sierra Nevada of California, snow depth in late spring may be enough to suppress activity of key prey species such as ground squirrels. This, coupled with the severity of the previous winter, may determine whether goshawks will attempt to nest or are successful.

From our observations in the Sierra Nevada, it appeared that those goshawk territories that contained unimproved logging roads, and were cleared of snow, were active more frequently than areas without snow removal. We think that these territories may have been active because rodents were active early in the spring and were more vulnerable to predation in the road clearings.

Age of the young was estimated on the basis of body size and feather development (Figures 3 and 4). We believe that ages assigned to young were accurate to within four days. The dates on which surviving young would have fledged were determined by projecting forward from the estimated average age of the young in each brood at the last nest visit. We assumed a fledging age of 40

Photo by Peter H. Bloom

Figure 3. Three-week old Northern Goshawk in ponderosa pine nest tree, Modoc County, California.

Photo by Peter H. Bloom

Figure 4. Branching age (5-week old) Northern Goshawk, Lassen County, California.

days. Fledging dates for Northern Goshawks in California for 1981-83 ranged from June 28 through August 9 and averaged about July 16 each year. Goshawks in the Northern Coast Ranges-Klamath Mountains region were the earliest to fledge.

An average clutch size of 2.42 was determined for the 24 nests that we visited by counting the number of unhatched eggs and adding to it the number of deceased and live young. This may have resulted in a figure slightly lower than what actually occurred since broken eggs and some dead young may have gone undetected.

The number of young fledged per active nest averaged 1.71 for 127 nests for the combined years 1981-83, and is virtually identical to the 1.7 reported by Reynolds and Wight (1978) for 48 nests in Oregon. Our figure falls between the extremes reported by Hakila (1969) of 1.5 young for 28 nests in Finland and that of McGowan (1975) of 2.4 young fledged for 11 active nests in Alaska in 1971.

The percent of nests where at least one young was fledged was quite high when compared with that for most other species of raptors. Goshawks fledged young in 91% of all nest territories examined. Similar results were obtained by Reynolds and Wight (1978) in Oregon where 47 of 52 nests (90.4%) fledged at least one young. Causes of nest failures included predation, falconry, and possibly, starvation.

These data suggest that the reproductive performance of Northern Goshawks in California is normal and indicative of a reproductively healthy population apparently free from the detrimental effects of pesticides. However, the number of active territories is decreasing at a probable rate of from five to 10 territories per year as a result of loss of nest territories to timber harvesting. During 1981-83, six territories on National Forest lands were reported to us as so altered that further nesting activity was considered unlikely. Several other territories which were determined to be inactive also had extensive logging activity within them. Because natural ecological factors such as prey abundance and weather affect goshawk breeding biology, we cannot positively assert that timber harvesting is the only reason for the abandonment of these territories. However, it seems likely since most of the trees in the territories were cut down.

We observed four territories whose breeding success was influenced by falconers; of these territories, three had all of their young illegally removed. These same three also were in areas closed to the harvesting of goshawks. One nest was affected by the legal removal of one young from a nest containing three birds.

The long-term effects of habitat loss on goshawks are much more serious than the ephemeral impacts that the effect of falconry has on the species. A large clearcut or an area where selective cutting is being performed on a large scale can negatively affect breeding goshawks for decades. While fledging success is reduced by falconry, the overall impact of the sport is relatively minor since the integrity of the habitat and territory remains untouched and the adults are normally able to fledge at least some young.

Habitat

Habitat parameters of nesting goshawks have been studied in the Northern Coast Ranges-Klamath Mountains (Hall 1984), and in the northern Sierra Nevada-Cascade Ranges of California (Saunders 1982). Habitat characteristics also have been examined in northeastern Oregon (Moore and Henny 1983). These studies have shown that goshawks in these regions nest in distinct coniferous stands of mature trees with low ground cover, high canopy closure and usually within 1.6 km (1 mile) of water. Because the major objectives of our study were to determine the status, distribution and abundance of the species, we were able to record only gross habitat characteristics.

No major differences in regional habitat preferences were detected other than those that could be attributed to elevation. We found that Northern Goshawks nested only in habitats dominated by coniferous trees, and that they tended to nest in those species that were most common. Most territories also contained openings, meadows or clearings of sagebrush (Artemesia sp.). Two hundred twenty-seven nest trees and alternate nest trees included 66 (28%) white fir (Abies concolor), 60 (25%) ponderosa pine (Pinus ponderosa), 28 (11%) Douglas fir (Pseudotsuga menziesii), 12 (5%) Jeffrey pine (P. jeffreyi), eight (3%) quaking aspen (Populus tremuloides), four (2%) white alder (Alnus rhombibolia), two (+) madrone (Arbutus menziesii) and one (+) incense cedar (Calocedrus decurrens). Most nests were located on one of the lowest live branches adjacent to the trunk. The height of the nest in the tree varied from 4.6 m (15.1 ft) to 22.9 m (25 ft). Goshawk nest territories ranged in elevation from 396 m (1,299 ft) on the northwest coast to 2,971 m (9,747 ft) in the Sierra Nevada.

Most of the habitat characteristics of nest territories examined in this study were similar to those found by other researchers (Saunders 1982; Moore and Henny 1983; Hall 1984) except that we observed more variability in the quality of habitat that goshawks will occasionally use. Seven pairs in the Great Basin region successfully fledged young from relatively dry, unsuitable appearing nest territories composed mostly of Utah juniper (Juniperus oteosperma) interspersed with groves of young ponderosa pine. However, territories such as these were rare and, we believe, exceptional. Although goshawks were observed to nest successfully in marginal habitat, the vast majority of pairs were found at high elevations (above 6,000 ft) in mature, uncut or mature second growth forests.

The majority (98%) of the goshawk nest territories reported to us during this study were on USFS property. Most were first located by USFS personnel while they conducted surveys for wildlife on proposed timber sale sites or were found by timber crews actually engaged in logging the nest territory.

Food habits

We collected 234 prey items representing 31 species over the three-year study period (Table 4). To assess dietary intake, we calculated prey biomass and frequency. Mammalian weights used in the estimation of biomass are reported

TABLE 4. Prey remains found at Northern Goshawk nest territories in California 1981-1983

SPECIES COMMON NAME 1/	Individuals		Biomass	
	No.	(%)	(g)	(%)
White-tailed Hare	1	+	4,000	6
Snowshoe Hare	3	+	4,080	6
Unidentified Lagomorph	4	2	10,720	16
Golden-mantled Ground Squirrel	22	9	4,950	8
Belding's Ground Squirrel	4	2	1,140	2
California Ground Squirrel	2	+	1,360	2
Douglas' Squirrel	48	21	8,880	14
Western Gray Squirrel	7	3	4,760	7
Northern Flying Squirrel	13	6	1,950	3
Unidentified Chipmunk	10	4	850	1
Unidentified Woodrat	2	+	960	1
Unidentified Mammal	6	3	1,500	2
Blue Grouse	8	3	6,160	9
Mountain Quail	4	2	920	1
Unidentified Galliform	1	+	500	+
Gadwall	1	+	920	1
Spotted Owl	1	+	610	+
Western Screech-Owl	2	+	340	+
Western Meadowlark	1	+	100	+
Common Raven 2/	1	+	600	+
Gray Jay	1	+	70	+
Stellar's Jay	28	12	2,940	4
Northern Flicker	17	7	1,955	3
Pileated Woodpecker	3	+	930	1
White-headed Woodpecker	1	+	60	+
Red-breasted Sapsucker	3	+	150	+
Williamson's Sapsucker	1	+	50	+
Hairy Woodpecker	2	+	140	+
Nuttall's Woodpecker	1	+	40	+
Band-tailed Pigeon	5	2	1,950	3
Mourning Dove	1	+	120	+
American Robin	12	5	900	1
Black-headed Grosbeak	1	+	45	+
Dark-eyed Junco	1	+	20	+
Unidentified Passerine	11	5	440	+
Unidentified Bird	5	2	250	+
TOTAL	234		65,360	

1/ See Appendix I for scientific names

2/ Nestling

in Burt and Grossenheider (1976). Avian weights were provided by Dunning (MS). In most instances, we assumed that the prey were adult-sized individuals. This probably resulted in an over estimation of the total weight for some prey species. Since the sex and age of many prey items were unknown, the biomass figures in Table 4 should be regarded as approximations.

By frequency, avian prey accounted for 68% of the total, while mammals comprised the remaining 32%. However, lagomorphs and sciurids made up 49% of the prey species taken, and 66% of the total biomass, providing the bulk of energy required for young goshawks. The four most frequently encountered prey species were the Douglas squirrel (21%), Stellar's Jay (12%), golden-mantled ground squirrel (9%) and Northern Flicker (7%). Similar results were obtained by Schnell (1958) in the Sierra Nevada mountains where the American Robin (31%), Stellar's Jay (25%), golden-mantled ground squirrel (7%) and Douglas squirrel (6%) were the four most common prey items brought to the nest. Unidentified lagomorphs (16%), Douglas squirrels (14%), Blue Grouse (9%) and golden-mantled ground squirrels (8%) provided the bulk of the total biomass in this study.

Schnell (1958) in a study of prey brought to a goshawk nest, found that a large proportion of the prey (60.5%) were nestling birds. Because our analysis is based upon a smaller sampling of one to two collections of pellets per nest, it may not accurately reflect the number of avian prey consumed. Nestlings may be both incompletely ossified and unfeathered, thus their remains may not be represented in a pellet. As a result, the data from Schnell's (1958) study and the present one may not be directly comparable.

Movements

Fifty-seven nestlings and 34 adult Northern Goshawks were banded to determine dispersal of young, migration, nest site fidelity, mate fidelity, mortality factors and recruitment rates. To date, no goshawks banded in California have been recovered. Only one goshawk banded from outside the state has been recovered in California. This bird was banded as a nestling male on the east side of Lake Tahoe, Nevada (Bird Banding Laboratory and R. N. Evans, pers. comm.). One nesting adult male banded in 1981 during this study was recaptured alive in 1983 at this same nest territory. This territory was inactive in 1982 (Hall, pers. comm.).

DISCUSSION

The phenomenon of goshawks in North America undergoing periodic invasions from the northern extremes of their range, (northern Canada and Alaska to the northern United States) has been well documented (Mueller and Berger 1967). However, invasions that project further south into areas like southern California are poorly documented (Colburn 1917; Grinnell 1917; Peyton 1917) and no longer seem to occur.

The fact that the Northern Goshawk was once "a common winter visitant" (Dixon and Dixon 1938) in southern California, and is now observed only as a rare vagrant, may be indicative of a population decline. Explanations of why this no longer occurs must include habitat destruction on both the breeding and wintering grounds as factors.

The effect of the legal falconry harvest on goshawks in California appears to be very low. The effect of illegal take of goshawks in the state is unknown. Approximately 30 Goshawks are legally harvested each year in California (R. Schlorff, pers. comm.) from our estimated 805 annually active territories. This represents about 2% of the total annual productivity of California pairs that produce young and is not considered a significant drain on the wild population. However, falconry can have negative impacts on localized areas or individual nest territories since some falconers, illegally and unethically, remove all of the young from the nests they find. Also, nests known by falconers can suffer from repeated annual harvesting. While not an important factor now, falconry must be monitored to determine if it will have an impact as suitable habitat is lost or certain regional populations decline.

Timber harvesting appears to be the most important factor adversely affecting Northern Goshawk populations in California. Silvicultural activities often preclude habitat characteristics necessary for goshawk reproduction, at least for decades following these activities. At some future date, these territories may become reuseable by goshawks, depending upon the type of harvest or silvicultural activities.

All four regions in the principal breeding range are losing territories due to habitat alteration or loss. Territories in the eastern Sierra Nevada are poorly occupied, but this appears to be temporary and is probably the result of the unusually severe winter weather conditions observed in 1982 and 1983. Populations in the Great Basin and Northern Sierra Nevada-Cascade Ranges regions are reproducing well and are probably maintaining themselves. The least amount of information has come from the western Sierra Nevada in the southern Sierra Nevada-White Mountains region. Reports of nesting activity in this area are not adequate to draw any conclusions regarding health of the population.

Results of this study indicate that the Northern Goshawk population size in California is relatively stable when compared with past declines of endangered species such as the Bald Eagle and Peregrine Falcon. However, due to current and projected levels of habitat destruction caused by timber harvesting activities, we urge that the population be monitored periodically to determine if State listing as Threatened or Endangered may be warranted at some future time. Plans for logging should consider the impact these activities have on goshawk territories on both private and public lands.

The future goshawk population in California will depend upon the quality of nest surveys, the number of territories the agencies and private foresters plan to manage for, the amount of acreage to be set aside in each territory and what is determined to be a "minimum viable" population by managers and planners with jurisdiction over goshawk territories.

In talking with biologists in the field, we found that the quality and understanding of nest surveys for goshawks sometimes suffered from three serious problems: (1) the inexperience of the biologist conducting surveys, (2) the short amount of time in which the biologist was required to complete the survey, and (3) the time of the year when the biologist was expected to conduct the survey. Biologists who are inexperienced miss more goshawk territories than those who are experienced. This is particularly true if the surveys are conducted between September and June when nesting activity is reduced or when the investigator is given an inadequate amount of time in which to complete the survey.

Missed nests prior to timber harvest may ultimately mean the loss of breeding territories. The majority of the territories identified in this study were found as a result of an active logging operation or were found by biologists surveying a proposed site for cutting.

We strongly recommend that any biologist who is expected to survey for nesting goshawks be trained by another biologist who has had experience with this species. Further, we propose that each biologist be given at least one entire day for every 5.2 square km (2 square miles) of proposed timber sale and that these surveys only be conducted from June 15 to August 15. Goshawk survey procedures should not be speeded up to meet deadlines.

The number of goshawk territories in California in the future will be determined by forestry plans. Management plans concerning National Forest lands currently contain provisions for the planned elimination of some active territories and the preservation of some active or historic territories. Other foresters in California do not have plans that address the goshawk or do not plan to avoid goshawk territories in their harvests.

Depending upon the National Forest, 10-32 ha (25-80 acres) of uncut timber are currently being left in the immediate vicinity of the goshawk nest trees. This acreage functions mainly as a buffer to the cut area surrounding the nest grove. Some territories are given two nest groves when distant alternate nests are known. Whether more habitat should be left intact throughout the pairs' territory is unknown. However, we do know that meadows, streams and aspen groves are critical to the key prey species that goshawks feed upon. These habitats, in addition to the 10-32 ha (25-80 acres) nest grove, should always be protected. We believe that this quantity of acreage is probably adequate in some instances where other factors such as abundant ground squirrels compensate for lost tree squirrels and avian prey. However, since these territories represent the viable population the forester is managing for, we recommend an increase in nest stand acreage from 10-32 ha (25-80 acres) to a minimum of 50 ha (125 acres), at least until adequate ecological studies are performed. In our judgement, this still places territories at risk and only selective cutting should be permitted adjacent to this area.

Since no studies of Northern Goshawk home range size and territory use have been conducted in California, our 50 ha (125 acre) figure should be regarded as a preliminary minimum estimate. A well-studied species, the Spotted Owl (Strix occidentalis) is at the same trophic level, is also classified as sensitive, and is being provided up to 400 ha (1,000 acres). Telemetry studies on goshawk home range size and territory use (winter and summer) must be completed before the habitat needs of the species will be known. These needs appear to be highly variable for different areas of California.

The adequacy of the acreage left in the nest groves depends, in large part, on the amount of trees remaining around the nest grove after logging. The nest stand functions as a buffer from the cut zone, but is also intended to protect some of the microhabitat requirements at the nest. Goshawks have relatively specific habitat needs (Saunders 1982; Moore and Henny 1983; Hall 1984). A complete clearcut up to the edge of the nest grove could render a territory extinct, but a small to moderate cut (up to an unknown quantity), should allow a traditional territory to continue to exist. Reynolds (1983) has a similar viewpoint and states, "nest sites should not be isolated by silvicultural treatments" (clearcutting, commercial thinning). If a substantial number of trees are left uncut around the nest grove, then a 10-32 ha (25-80 acres) nest grove may be adequate. However, if a large quantity of trees are to be harvested from inside the nest territory, then the nest grove should be proportionately larger.

We feel that protecting only a nest stand probably is not adequate to maintain a productive territory. Without prescribed habitat preservation throughout a large part of a territory, the effects of a substantial timber cut could eliminate a pair of nesting goshawks. Schnell's (1958) food habits study shows a strong dependency of nesting goshawks upon nestling birds as prey. Intensive logging inside a territory, even if the nest grove remains intact, could significantly reduce or alter the number of birds or mammals available within the area, and thus affect reproductive success of goshawks.

It is not clear how the "viable population" level will be estimated, nor if current plans will reduce the population below a viable level. Historically, the California goshawk population was larger than it is today. Land use activities, including timber harvesting, recreation and urban development, water impoundments and other uses have reduced the suitability and overall acreage of forested lands to provide for goshawk breeding and foraging activities. Activities are still occurring which are detrimental to goshawk habitation of lands within its breeding range. While the present population is being reduced at a slow rate, public land management agencies and private landowners propose future resource management activities, most notably timber harvesting, that may well preclude goshawk habitation of many of these lands under their ownership or jurisdiction.

We have little data available upon which to draw any conclusion as to what population levels are necessary to maintain viable breeding populations of goshawks throughout the range of this species in California. It may be that the goshawk population is reaching levels of questionable viability in some areas at this time.

PROPOSED RESEARCH

To aid in goshawk management decisions, we propose a study to determine the status of nesting territories where logging has occurred or is being planned. A sizeable number of Northern Goshawk territories statewide have had varying levels of logging occur within their boundaries. Compiling data from these territories would provide insight into the impact of logging on goshawks, the amount of acreage needed to adequately protect nesting territories from disturbance, and the amount of timber that can be harvested without adversely affecting the reproductive success of the species. The proposed study would involve aspects of goshawk ecology and quantification of the effects of habitat alteration. Major objectives of such a study would include investigations to: (1) quantify current vegetative and physical characteristics of goshawk nesting territories already logged, (2) quantify habitat characteristics at preselected territories both before and after logging, (3) document adult responses, to a range of intensity of logging activity (i.e. reproductive failure, abandonment, no change, emigration, death, etc.), (4) analyze prey populations and food habits before and after logging and (5) determine home range size and habitat use through radio telemetry.

Monitoring the effects of different levels of logging activity on goshawks and their nests would necessitate permanently marking the adults for individual recognition. Numbered, colored and plastic leg bands that are visible from 50 m (164 ft) could be used to achieve these results. Each pair of goshawks would have the same color and number, but the color band would be placed on a different leg, depending upon the sex. A standard aluminum lock-on band from the United States Fish and Wildlife Service (USFWS) would also be placed on the goshawks' legs. This technique would allow sight recognition of individuals inhabiting certain nest territories and has been used with good success on Red-shouldered Hawks (*B. lineatus*) and Swainson's Hawk (pers. obs).

The proposed study would necessarily be of several years duration. One to two years would be needed to quantify habitat characteristics. Studying the effects of logging on reproduction, and nest, mate, and territory fidelity would involve several successive years, but would require only a minimum time expenditure per season and would be relatively inexpensive. Thirty-four adults have already been banded so that some results could be immediate if we returned to color-mark them and found them still present. In addition, dispersal information might be obtained if any of the 57 goshawks banded as nestlings were recaptured at active territories. Costs of the proposed project would include time to quantify habitat characteristics, plastic bands,

time to capture adults and follow-up annual surveys to determine if territories are active and if birds have survived. Each bird need only be seen once each spring which can be accomplished either by one day observations from a blind, or in the case of aggressive individual goshawks, by walking through the territory and observing with a spotting scope. When an unmarked adult appeared at a nest territory that contained marked adults, it could be assumed that the previous individual had died since the last observation. Adjacent territories would also be examined to determine if individuals ever exchanged territories. Observations would continue until both marked individuals disappeared in each territory.

Prey populations can be surveyed using standard mammal trapping and avian census techniques. Census figures would be used to analyze the effects of logging on prey abundance.

Radio telemetry has been used successfully on a variety of raptors, including goshawks, to determine home range size and to study behavior and habitat use (Detrich and Ellenberg 1981; McCrary 1981). At present, no information concerning the home range sizes of Northern Goshawks in California is available. To provide information on home range size, at least three pairs of goshawks in each of the 4 principal geographic regions of the state should be fitted with radio transmitters and monitored throughout the breeding season. This information would be useful in ultimately determining the size of a timber stand necessary to preserve a viable goshawk nesting territory.

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