FINAL REPORT

APACHE GOSHAWK CONSERVATION BIOLOGY

IN SOUTHEAST ARIZONA

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by: Helen Snyder
P.O. Box 426
Portal, AZ 85632

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INTRODUCTION

The northern goshawk (*Accipiter gentilis*) is a panboreal Accipiter with several described subpopulations. It is primarily a bird of the northern coniferous forests, hunting below the canopy for medium-sized birds and mammals in the size range of jays, pigeons and squirrels (Cramp, 1980; Palmer, 1988). The goshawk's conservation status is of concern today in much of the American west, primarily because it utilizes old-growth habitat over much of its range that is or has been targeted for timber harvest.

The northern goshawk is not a Federally-listed species, but has been petitioned for listing (USFWS 1991). It is currently a Category II species undergoing a status review (USFWS 1992). The U.S. Forest Service Region III considers it a Sensitive Species (USDA Forest Service 1988) and has issued management guidelines for the species in the southwest. Arizona lists it as a candidate species (AGFD 1988).

SOUTHWESTERN GOSHAWKS AND THE APACHE GOSHAWK

The North American population is considered taxonomically to be the northern goshawk subspecies, *Accipiter gentilis atricapillus* , although a total of five races have been proposed at various times(Whaley and White 1994). The Apache goshawk (*Accipiter gentilis apache*) from northern Mexico and southern Arizona and New Mexico is one of these.

The Apache goshawk was described as a larger, darker, longer-winged subpopulation of the northern goshawk (Van Rossem 1938). It was reported to occur in the southernmost part of the species North American range, from the mountains of southwest New Mexico and southeast Arizona through the Sierra Madre Occidental of Mexico. Whether this population is taxonomically distinct unit is a matter of current debate: Whaley and White (1994) consider it worthy

of a separate designation on the basis of measurements, while Reynolds, Gavin and May (pers. com.) are currently looking for differences at the level of DNA using blood samples drawn from birds on the Coronado National Forest (CNF), central and northern Arizona and from across North America, and have not yet presented their results.

The described range of the putative "Apache" goshawk in the U.S. generally coincides with the boundaries CNF, a 1.7 million-acre component of the National Forest system. The CNF is comprised of a dozen separate mountainous "islands" of forest habitat southeast Arizona and southwest New Mexico. Adjacent National Monuments and private inholdings provide some breeding habitat but surrounding by CNF lands which provide the majority of the foraging habitat utilized by these pairs.

In the western United States most of the goshawk population nests on public lands administered primarily by the U.S. Forest Service. Concern over the status of southwestern goshawk populations, i.e. those occupying lands administered by Region III of the U.S. Forest Service, has focused on the harvest of old-growth timber north of Arizona's Mogollon Rim, most notably the North Kaibab Ranger District on the north rim of the Grand Canyon. Crocker-Bedford (1990) reported a decline in numbers of nesting goshawks there due to timber harvest . Since this publication much attention has focused on the status of the northern goshawk in the southwest and lead to the publication of management guidelines for the goshawk by Region III (USDA 1992).

Region III Goshawk Management Guidelines mainly address management needs in timber harvest areas, where loss of nesting habitat and alteration of foraging habitat have occurred because of logging. Unlike most Region III forests, the CNF is not managed primarily for timber. Timber harvest acreages on the CNF have been small compared to other forests, and they have decreased in recent years from 311 acres in 1987 to 0 in 1994 (UUSDA TSPIRS data, unpublished) . Recent saw timber logging has been minimal on a percentage acreage basis compared to other Southwestern forests, probably because it is uneconomical to harvest timber occurring in small isolated patches in extremely rugged, mountain terrain as is the case on most of the CNF.

Two other forms of tree cutting occur on the CNF. Fuelwood harvest (mostly of evergreen oaks, pinyon and juniper at middle to low elevations, by individual permit) has been an ongoing use of trees on the CNF and one with possible effects on the goshawk. A total of 4,231 acres of fuelwood have been harvested on the CNF in the past 8 years. The remaining form of tree harvest is the much smaller-scale cutting of conifers under individual permit for Christmas trees.

On the CNF, management of goshawk habitat on the Coronado primarily conflicts with recreational developments. The CNF's steep mountains have limited flat space for campgrounds and roads. Goshawks on the CNF also seem to prefer this same flatter terrain on the CNF, resulting in nest areas within or adjacent to the same areas that are desirable for human uses. Current campground construction plans in the Catalina and Pinaleno mountains will affect nesting goshawks, and USFS draft concept plans have been presented for the Chiricahua mountains that will affect other pairs if implemented. Direct conflicts between goshawks and people have resulted in goshawks being killed around the nest; for example, in 1988 the adult male from territory# 3107 was found dead below the nest tree, having been shot probably from the adjacent trail. Other conflicts have occurred because of the presence of recreation sites near nesting areas; in 1994, construction on Twilight Campground in the Pinaleno mountains was delayed because of nesting goshawks.

In addition to these recreation-related pressures on CNF goshawks, in the early 1990's Arizona Game and Fish Department became aware of an ongoing, illegal harvest of 'Apache' goshawk nestlings presumably by out-of-state falconers. The extent of poaching was unknown. Arizona has not permitted the harvest of goshawks for falconry since 1991, and never from south of the Gila River.

HISTORY OF SOUTHEAST ARIZONA GOSHAWK STUDIES AND BACKGROUND OF THE PRESENT PROJECT

USFS interest in knowing more about the status of the goshawk on the CNF dates back to 1991 when all Region III forests were asked to assemble all

known information on goshawk locations. I was asked to assist on this as I had approximately 20 historic records for goshawks on the CNF dating back to the late 1960's and early 1970's (Snyder & Glinski, 1978).

In 1992 I was contracted for one year by the CNF and AGFD to revisit and map historic nest areas, check for current activity at historic territories, inventory 7,500 previously-unsurveyed acres of suitable habitat, and monitor reproductive activity (USFS Agreement no. CCS-3-92-05-00-11). I have included some of the result from that year of study in this report, as noted below.

PROJECT GOALS

A grant from the AGFD Heritage Fund for 1993-1994 (#I-9265) permitted continuation and expansion of earlier work on goshawks in southeastern Arizona. The goals stated in the proposal for this project were:

1. To describe the historic and current numbers and distribution of the Apache goshawk in southeast Arizona, and to set up a long-term monitoring program.
2. To produce a database containing nest-area locations and habitat measurements, including maps and photographs, for use of resource managers.
3. To evaluate and make recommendations on the U.S. Forest Service's protocols for inventorying goshawks and goshawk habitat management guidelines, and to develop management recommendations specific to the needs of the Coronado.
4. To determine annual occupancy and productivity for active territories, and population parameters such as dispersion, mortality, and recruitment.
5. To determine the primary prey in the diet of the Apache goshawk in major habitats used by the bird.
6. To describe the foraging range and habitat utilization of selected pairs in three different habitats, with emphasis on the use by the Apache goshawk of oak woodlands.
7. To determine the genetic distinctiveness of the Apache goshawk through DNA fingerprinting and comparisons with other populations.
8. To describe the major threats to this population, and work with the Forest Service and Arizona Game and Fish to develop management recommendations.

This report covers items #1- 5 and 8. #7 is in the hands of Richard

Reynolds (U.S.F.S.), Tom Gavin and Bernie May (both of Cornell University) who are doing the DNA work with blood I have collected for them from the Coronado

In January 1994 I reviewed the progress of this contract with the CNF and AGFD. At that time, we proposed to eliminate step #6 (radio-tracking and associated habitat studies), in favor of increased inventory and monitoring, as it was felt that the identification of historical and active nesting areas was of greater importance to managers. This change was later formally agreed to by AGFD's Heritage Projects Coordinator.

STUDY AREA

The study area is a .series of isolated mountain ranges which lie in Cochise, Santa Cruz, Pima, and Graham counties of southeastern Arizona (Figure 1) . Most of the public land is in the study area is the CNF, which comprises 1.7 million acres. Other forested lands in the study area which are adjacent to and within CNF boundaries include some small private inholdings, and other public lands administered by the National Park Service (Saguaro, Coronado and Chiricahua National Monuments) and the Department of Defense (Ft. Huachuca). The Peloncillo mountains (Hidalgo County) of extreme southwestern New Mexico have been included in this study because they are part of the Coronado National Forest

The study area is a physiographically and biologically diverse area. Geologically it derives from the basin and range formation and consists of a series of forested mountain "sky islands" formed from ancient volcanic activity. Elevations range from approximately 2,000 to 11,000 feet. Annual rainfall varies from about 10 inches at lowest elevations to 25-30 at the highest. About half the rainfall comes during summer "monsoons" from mid-July to August, and the other half comes from Pacific storms in winter. May and June are normally quite dry.

Plant communities are diverse and include Semidesert Grasslands at lower elevations. Madrean Evergreen Forest and Woodland (Emory Oak and Oak-pine) associations occur at low to middle elevations. Interior Southwestern Riparian Deciduous Forest and Woodland associations are

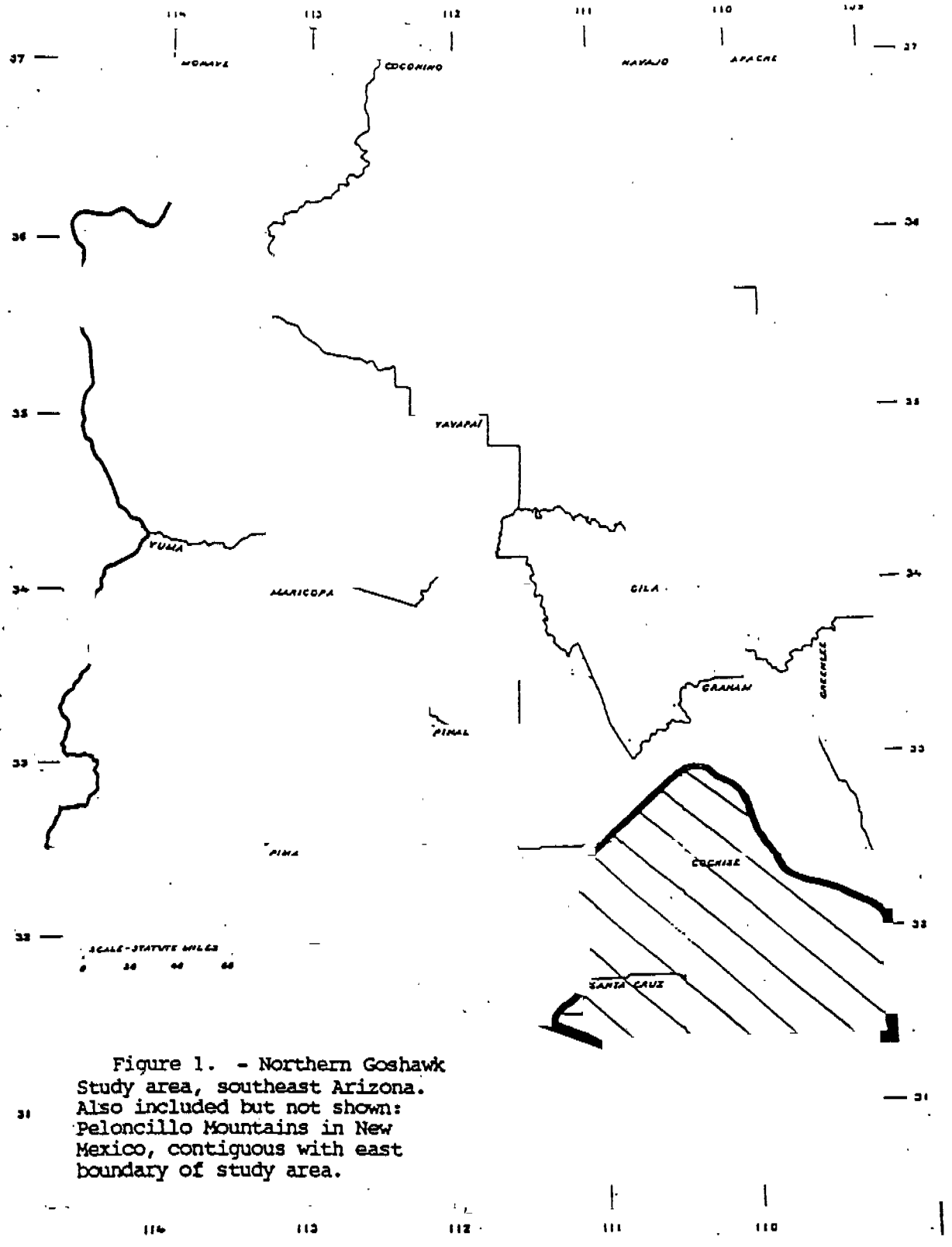

Figure 1. - Northern Goshawk Study area, southeast Arizona. Also included but not shown: Peloncillo Mountains in New Mexico, contiguous with east boundary of study area.

common along drainages at middle elevations along with the Relict Conifer Forest/Arizona Cypress and Ponderosa-Chihuahua Pine associations, and Rocky Mountain Montane Conifer Forest associations occur on the higher mountains, typically several Ponderosa pine and Douglas Fir-mixed conifer. Rocky Mountain Subalpine Conifer Forest/ Engelmann spruce-Alpine Fir association is found on the highest peaks of the Pinaleno and Catalina mountains. (Brown, Lowe and Pase 1979). Pinyon, oak, juniper and chaparral associations typically cover hillsides not associated with drainages.

Most suitable goshawk habitat exists as 'stringers' of trees down canyon bottoms or in groves on dry streamside terraces. The only extensive stands of closed-canopy coniferous forest occur on some of the mountaintops.

METHODS

A. HISTORICAL RECORDS

At the beginning of this study there were 50 known historical goshawk nesting records for the study area, and during the study I sought more. Sources of these nesting records include museum skin tag data, published records, verbal accounts from knowledgeable sources, and nests located by myself and others during the course of other work between 1969 and 1990. Further active and recently-active nests were located by me, my assistants and other people doing field work on the CNF between 1991 and 1994.

Verbal records from individuals I did not know personally were weighed carefully and were included only if it seemed likely that the identification of the birds was correct (confusion with Cooper's hawks was a problem), and that some sort of nesting behavior was involved. Thus, accounts of young goshawks on the wing and calling early in the post-fledging period, or adults copulating, or calling defensively and flying repeatedly around an area were included, while single sightings of nonvocal individuals were not considered significant unless a record of additional territorial activity was discovered.

B. SURVEYS FOR ACTIVE NESTS

My assistants and I resurveyed known historic territories and new areas of suitable habitat during this study in order to determine current and recent occupancy. We used a combination of the USFS Region III goshawk inventory protocol, which constitutes a systematic method of grid-searching appropriate habitat using tape playbacks of goshawk vocalizations (Kennedy and Stahlecker 1993), and foot searches in which we looked for signs of goshawk nesting activity within 1.6 mi. of known historical sites. Over much of the CNF, and in particular the mid-elevation areas where trees grow in narrow strips down drainage bottoms, a foot search is a practical alternative to the more time-consuming tape-playback search for occupied territories.

Some of these areas were searched in the non-nesting season in order to locate old goshawk nests or areas of likely habitat to return to and inventory with tape-playback during the breeding season. Aerial photos were also examined to locate otherwise-hidden pockets of potential habitat to survey in some of the drier, less forested parts of the CNF.

We concentrated our surveys for new territories on the Chiricahua, Pinaleno, Santa Rita, Catalina and Huachuca mountain ranges. Our coverage was not uniform, in that we did not survey the Whetstones, Galiuros, Dragoons, Winchesters, Rincons or much of the Peloncillos or Atascosa Mountains but concentrated instead on higher, larger , and more heavily-forested mountain ranges. Not all potential goshawk habitat has been surveyed in these areas. We resurveyed some areas covered in previous years by other goshawk survey crews if I had a historical breeding record for that area. See Appendix I for maps of areas surveyed

When two active nests were found within 3 miles of each other we surveyed all potential habitat between the two nests with extra thoroughness, using foot searches and tape inventory, to establish minimum spacing between active territories.

C. TRAPPING, BANDING AND BLOOD-SAMPLING

Adult goshawks and flying young were trapped with a Great Horned Owl and dho-gaza or a bal-chatri (Bloom 1987). Nestlings were banded with USFWS aluminum lock-on bands at between 21 and 40 days of age. Nestlings were aged by my knowledge of hatching dates and by comparison with photographs in Boal, 1994. Blood for DNA analysis was drawn by sterile needle and syringe from the brachial vein and was put into a buffer solution supplied by Tom Gavin, as per his protocols (Gavin, pers. com.)

D. MONITORING FOR OCCUPANCY AND PRODUCTIVITY

Recently-active goshawk nest areas were checked for signs of reproductive activity beginning in February in order to obtain a sample of occupied territories for productivity studies, and to determine when breeding activity starts to provide data to managers for setting seasonal closures. These checks were performed by listening near the territory early in the morning for sounds of activity, and by checking for signs of fresh nest construction, pluckings, and whitewash.

Visits to nests to determine occupancy, egg laying, incubation, hatching, and fledging were standardized in that they resulted in the same high level of certainty about success of the nest and the stage of nesting.

The main data-collecting visits during the nesting season were performed as close to the same stage for each nest (as opposed to a calendar date) as possible, but since the CNF, which is only part of the study area, is 2.5 times as large as the North Kaibab Ranger District, travel time was a factor. Making a single round trip to each active nest from my home in Portal meant 3100 miles of travel and 74 hours of driving time, while the most efficient possible circuit to cover all occupied nests requires about 26 hours at the wheel, plus walking time to and from nests. All nests could not be checked on a single circuit, due to the asynchrony of these pairs. Thus, to check all nests for hatching, for example, required several multi-day trips spread over a two-(or more) week period.

Nests were checked at least once during incubation and several times

during the nestling phase, at banding, within 2 weeks of fledging and again 4 weeks after fledging to determine the number of remaining young. Failed nests were climbed in most cases within 24 hours of the discovery of failure in order to determine as much as possible about causes of failure before scavenging occurred.

Determinations of the number of young on the wing after fledging were made as follows: if the same number of chicks that were banded was later found on the wing, either by hearing the known number of chicks calling from different parts of the post-fledging area (PFA) or by seeing them, the visit was concluded. If fewer than the number fledged was encountered,the observer sat inconspicuously about 75 yards from the nest and waited until prey was delivered by an adult, which generally happened about every three to six hours early in the post-fledging dependency stage, and once or twice a day later in the cycle. Even the most recently-fed, non-calling young will call at this point. This is based on several seasons of behavioral observations involving thousands of hours made at Accipiter nests in the late 1960's and early 1970's, when several broods were followed daily till disappearance from the territory. A single-visit, post-fledging chick count can thus be the most time-consuming, and it sometimes took a full day to reach the required high level of certainty about the number of young surviving on that date.

During the post-banding visits the chicks' bands were read with a telescope to determine which member(s) of the brood had not been seen. Before the FWS aluminum lock-on bands are applied to goshawks I darken the numerals with black paint and clean the excess off the surface with fine steel wool. These can be read these with a Bushnell Spacemaster telescope with a 22X eyepiece from 175 feet. I vary the band's position and banding leg within a brood, so that a determination of who survived may be made without having to read the numbers themselves.

The movements of the fledged young were mapped by sitting at an overlook and watching and listening for calling, flying or perched fledglings.

In 1994 I made an effort to check on fledglings every 2 to 3 weeks at as many territories as possible in order to determine when they dispersed or

disappeared (none was radioed), to determine cause and timing of death if losses occurred, to map their use of the post-fledging area, and to provide managers with the date when seasonal closures could be lifted. Visiting active nests was constrained by the extremely scattered nature of the active nests, particularly in 1994 when it would have required over 3,000 miles of driving to make a single round trip to each nest from my home base.

E. NEST AND HABITAT MEASUREMENTS

Nest and nest-area habitat measurements are included only for territories which had one or more existing active or previously-active nests, or where I was able to relocate and measure nest trees that I knew had once held an active nest, whether the areas were active in the study years or not. Some territories had more than one alternate nest and thus contributed more than one nest to the nest-tree measurement data set.

Data were recorded for all nests and known nest trees in the nest stand, as well as the active one. Instruments used were a Silva compass with clinometer, a home-made clinometer, various tape measures and US Geological Service topographic maps.

F. DIET AND PREY REMAINS

Prey remains were collected opportunistically and incidentally, whenever nests were visited for other purposes, such as banding or checking fledgling survival and movements. On early-season visits, time at the nest area was minimized and so no extensive prey-remains collecting was done until banding day, when a thorough search was made of the ground under plucking posts. On banding day remains were collected in the nest itself for the first and only time in the season. Relatively few prey remains were encountered on early-season visits up to the mid-nestling stage; this may be because adults are strong enough to completely devour many of the animal species on which they prey, leaving few remains, and also because the pair's food needs are less than they are from mid-nestling stage on.

Some prey remains were collected from goshawk nests which had been active in a recent, previous year, and where there were still dozens of bones,

feathers and molted goshawk feathers below the nest, thus identifying the nest as having been goshawk and active, and not just a feeding platform for a passing raptor. No species of prey new to the diet list were added from these collections at inactive nests, however.

Prey remains were bagged and labeled by site and date, and stored in mothballs until identified in the fall of 1994. They were identified using reference specimens and skeletons at the University of Arizona and the American Museum of Natural History's Southwestern Research Station.

RESULTS AND DISCUSSION

A. HISTORIC RECORDS

A total of 70 records for goshawk nesting territories have been located to date on or near the Coronado National Forest (see Appendix III). Each represents a discrete nesting territory; some contain more than one nest or nest area. By the end of 1994 I eliminated 5 of these records because I judged them to be without sufficient data to permit an accurate location to within .6 mi. This reduction has led to gaps in the numbering system that I initiated 1992, in which a 4-digit number denotes a territory, the first digit identifying the ranger district of the territory according to the CNF district numbering system.

Of the remaining 65 records, 57 are on the CNF, 3 are in Saguaro National Park (National Park Service), 2 are on Ft. Huachuca (Department of Defense), 2 are on private land, and 1 is on the Chiricahua National Monument (National Park Service). I have excluded the 3 on the Saguaro National Park in the Rincon mts. for logistic reasons, so this study is based on the remaining 62 records. Four of these records are for territories that are within .8 mi.or less of a recently-active area, and are probably too close (because of the observed minimum spacing on the CNF, see below) to be active in the same year, but are too far apart to be considered alternates for the same nest area. The nesting habitat is not contiguous between these pairs of nests; each is in a separate, well-developed grove of trees with sparse open vegetation between.

Thus, there are effectively a potential of 58 (minimum) to 62

(maximum) nest territories for goshawks on the Coronado.

Fifty-six of these records represent documented historical breeding records, i.e. sites where adults were observed and heard performing courtship activities, active nests were found with eggs or chicks, or fledglings were seen. The remaining 6 records are for individual inactive nests or nest clusters that I deemed very likely to have been built by goshawks in the past, but for which I have no conclusive evidence of what species constructed them. I classified an inactive nest to be goshawk if it was located in the horizontal lower branches of a tree situated in a typical goshawk nest grove of large, well-spaced with an estimated > 50% canopy closure, was built of sticks > .5 inch thick, and lacked *Agave* leaf bases on the nest or on the ground below (these or other fibrous material are commonly added to nests by red-tailed hawks,but apparently never by goshawks).

Some sites had nests meeting these goshawk criteria but were active with Cooper's hawk in the year found. They are included because I have had cases of goshawks moving into other hawk species' inactive territories and vice versa. Exchanges both ways have occurred between goshawks and Cooper's hawk, zone-tailed hawk and common raven. I have included them also because they should be flagged and resurveyed in the event future management activities are proposed for the areas.

Many other large stick nests were found during the course of this study, but were rejected as potential goshawk sites because they were not judged to be in appropriate habitat. The species responsible for these nests include Cooper's hawk, zone-tailed hawk, red-tailed hawk, and common raven.

B. SURVEYS

A total of 28,722 acres of goshawk habitat have been inventoried by tape playback on the CNF to date (Table 1). The 28,722-acre total does not include 8,700 acres inventoried by other contractors in 1991, and other acreage inventoried by CNF technicians working under the district biologists in 1994. Inventory by tape playback has led to the location of 5 active nesting areas. Three of these were found by me and my assistants and two were found by technicians working on the Catalina Ranger District; all were found in 1994.

One was found after it failed at the young-chick stage, and the other four were located after the chicks had fledged. Two of these are new nesting areas and three should probably be considered as previously-known historic nesting areas for which an active nest is now known again, because of their proximity to historic sites.

A summary of tape-playback inventory on the Coronado during my years of study is as follows.

Table 1 - Acreages inventoried for goshawk nesting activity using Region III protocol on the CNF by year and ranger district

Year	Acreage inventoried	Subtotals by ranger district	
1992	7650	Douglas	2600
1993	2607	Douglas	685
		Sierra Vista	119
		Safford	1803
1994	18,465	Douglas	9145
		Nogales	2390
		Sierra Vista	2580
		Safford	2220
		Catalina	2130
	Total = 28,722		

An additional 65,000 acres have been cleared, either by inspection of habitat by aerial photo (the bulk of the acreage) or from the ground (areas of bare rock upslope of survey drainages were eliminated this way), or because acreage was part of a historical nesting area that was foot-searched before the start of inventory work and was found to have goshawk nesting activity.

Without vegetation maps or GIS capability for the Coronado National Forest it is difficult to estimate the total amount of potential goshawk habitat on the Forest and thus to know what proportion of nest territories have been identified. It is likely that more territories were active in 1992-1994 than I have discovered, but it seems unlikely that a great many more territories exist because in my searches for nest records and appeals to other field people for information, the same historical and current territories kept getting reported to me over and over, without many new ones being added.

C. TERRITORY ACTIVITY

Forty-eight of the 62 historic sites were checked for occupancy in 1993, and all 62 were checked in 1994 except one which was learned of in December 1994.

It is unlikely that all 62 of these territories were ever active at once, as in most raptor studies where most or all of the nest areas have been identified, there are some vacant territories every year (Newton, 1979).

The maximum known number of goshawk territories on or near the Coronado with any sign of goshawk presence in the last ten years now stands at 46 (Appendix III), or 74% of the total known territories. Twenty of these sites had activity between 1985 and 1991, but did not have activity during 1992-1994, the period covered by this report. Of the remaining 26, 2 sites had a single non-vocal male sighted once during the study years.

The other 24 (39% of the total) of these had reproductive activity (i.e. were occupied) by one or more adults displaying reproductive behavior during the study years (1992-1994). At 2 of the 24 sites, a male was seen carrying prey or heard calling early in the season but despite searches no further sign of nesting was found. 15 (24%) were productive (fledged 1 or more young) in 1 or more years 1992-1994, and an additional 7 (11% of the total nest areas; 29% of the occupied sites) had an active nest but never fledged young in the 1992-1994 period. Note that these figures are on a per-nest area basis, not per-nesting attempt basis (for the latter see Table 2). Viewing the data this way identifies those territories which are consistently active but unproductive, as opposed to those which are regularly the source of young birds, and which are thus most important to the population.

D. SPACING OF ACTIVE GOSHAWK TERRITORIES

Active raptor territories may be spaced at different intervals in different habitats (Newton et al 1986). Most studies in which nearest-neighbor distances have been calculated for different habitats involve studies where nests were spaced throughout contiguous. For goshawks on the north Kaibab Ranger District in northern Arizona, the mean distance between 59 pairs in

contiguous habitat was 1.8 mi., with a range of .7. to 4.1 mi. (Reynolds et al 1994).

Comparison of goshawk density studies with the results of this study are complicated by the fact that in my study area goshawk nesting habitat is extremely patchy and irregularly spaced. I have therefore not calculated means and ranges by using all active pairs, but have restricted the analysis to several instances of known minimum spacings.

On the CNF in 1992-1994 I had 4 instances in which I was certain that knew the minimum spacing between pairs of simultaneously active goshawk nests (Table 2) because we made intensive searches for active nests between pairs of active nests wherever there was potential habitat in between. Most goshawk habitat on the study area is extremely disjunct, and in the case of these four pairs a complete search was relatively easy because the area was relatively small and much of the intervening terrain was sparsely vegetated with rocky outcrops and cliffs.

The only place where I had 3 simultaneously-active territories spaced linearly in contiguous forest habitat was in the Pinalenos (Table 2), where the mean distance between the 2 sets of paired territories was 4.45 mi. These two inter-pair distances (4.1 and 4.8 mi.) were greater than the other four on other mountain ranges. We surveyed the most suitable habitat between these three pairs, but coverage was not as exhaustive as it was in the other four cases, due to the greater spacing of pairs and the extremely steep terrain and difficulty of access.

Table 2 - Distance between nearest-neighbor goshawk nests on the CNF, southeastern Arizona.

Mountain range	Sites	Year	Distance between sites
Chiricahua	1025 & 1030	1994	2.8 mi
Chiricahua	1028 & 1020	1993	2.8 mi
Patagonia	3105 & 3107	1992	4.0 mi
Catalinas	5002 & 5007	1994	2.2 mi
Pinalenos	4001 & 4002	1994	4.8 mi
Pinalenos	4002 & 4003	1994	4.1 mi

Alternate nests within a single nest area were spaced at at average of 260 yards apart, with the farthest- apart pair of nests in a single nest area being 338 yards apart.

E. BANDING AND BLOOD-SAMPLING

A total of 39 goshawks were banded during 1993-1994. All were blood-sampled for DNA studies of the Apache goshawk, as were 7 additional birds from 1992. These samples have been sent to Cornell University for DNA studies and to Bob Sheehy of the University of Arizona. Sheehy is attempting to work out some family lines so that breeders may be identified back a year or more before they were trapped and sampled by comparing their known offspring in the sampling year with putative offspring from a previous year at the territory. See Appendix IV A for band and measurement data.

This will give additional years of occupancy, longevity and turnover information if it can be done. See Appendix IV B and C for pedigrees for this work with blood samples, and the specific questions that may be answerable by it. There are some differences in sample numbers between the U. of A. and Cornell U. subsets because I did not receive the collection materials from Cornell early enough in 1992 to collect blood from all birds I handled that year. Both studies have begun lab work and have extracted the DNA for these studies. Reynolds and Gavin expect to have results by fall of 1995, as does Sheehy.

F. GOSHAWK PRODUCTIVITY

In 1993 I checked 48 of the then-known historic territories for activity, and in 1994 all known territories were checked. Not all of these checks were made before the start of the incubation period however.

The 1993-1994 productivity data are presented in Table 3.

TABLE 3 - Summary of goshawk productivity in 1993 and 1994 on the Coronado National Forest, Arizona

1993	Nests found before egglaying	Nests found after hatching	Total
Number of occupied territories:	9	5	14
Number of active nests:	5		
Number of successful nests:	4	5	9
Stage at which failure occurred:			
Pre-laying	4		4
Incubation	0		0
Chicks 1-2 weeks old	0		0
Chicks 2-4 old	1		1
Number of chicks fledged	11	5	16[1]
Mean number fledglings/occupied terr.		**1.2**	
Mean number fledglings/active terr.		**2.2**	
Mean number fledglings/successful terr.		**2.75**	
1994			
Number of occupied territories:	10	5	15
Number of successful nests:	7	4	11
Number of active nests:	9		
Stage at which failure occurred:			
Pre-laying	1		1
Incubation	1		1
Chicks 1-2 weeks old	1	1	2
Chicks 2-4 weeks old	0		0
Number of chicks fledged	10	8	18[1]
Mean number fledglings/occupied terr.		**1.0**	
Mean number fledglings/active terr.		**1.1**	
Mean number fledglings/successful terr.		**1.4**	

Productivity figures in bold are calculated from nests found before egglaying only

[1] Some active nests in each year were reported to me only several weeks or more after fledging. These are not included in these tabulations, as I could not be sure of the actual number of young produced. These reports of fledglings are included in the site list, Appendix III.

G. TIMING OF BREEDING

Three pairs during the study have begun nestbuilding as early as the 3rd week in February, when I first noted fresh sticks on old nest, down and whitewash under nearby perches. Most pairs were present and building nests by the end of March.

Timing of onset of reproduction may depend on whether the previous breeders are still in residence or whether new pair members are involved. The earliest dates for nestbuilding all involved one or two marked, returning adults. In one case a banded female (Site 3005, 1994) returned and began nestbuilding and calling by March 7, but with no sign or sound of a male present. She was calling alone again on March 16, with only calls from a single bird audible in the vicinity of the nest, and again on April 8, but she was incubating on April 28. Her nesting effort was several weeks later than normal, and was one of the latest of 1994 whereas that territory is normally an early one. The male at this territory was not banded until 1994 so I don't know whether her previous mate returned or whether she acquired a new one.

Nineteen ninety-three was the best year for goshawk productivity on the Coronado for which I have records, and it was also the earliest. We banded young on average 1-2 weeks earlier in 1993 than in other years.

Young of the year remained on the nesting territory until approximately September 1, when they became undetectable. None were radioed.

H. CAUSES OF MORTALITY AND NEST LOSSES

18 breeding adults have been trapped and banded to date on the Coronado, including both members of 6 pairs. It is too early to say much about adult survivorship; one marked pair in 1993 remained together to breed in 1994, and 2 marked females have remained with their same territories to breed the following year.

Two cases of adult mortality have come to my attention during the course of my study. These are presented in Table 4.

Table 4- Cases of adult goshawk mortality, 1992-1994 in southeast Arizona

- 1994 - One adult breeding male trapped in June 1994 at site #4003 in the Pinalenos was picked up dead in late November 1994, 11 air miles from his nesting area. This suggests that these goshawks are not strongly migratory in winter, at least as adults. The carcass was disposed of by the individuals who found the bird so it was not available for necropsy, but they informed me. it did not look emaciated or appear to have been shot.

- 1992 - One adult female, presumably the nesting adult from site #5-004 but this is not proven, was picked up freshly dead beside the trail a few hundred yards uphill of the nest area. The carcass was necropsied by Tom Huels, curator of birds at the University of Arizona, who reported to me that the bird had a large area of a pinkish lesion on the underside of one wing and on the adjacent part of the breast. He felt it was the result of infection and not trauma. No cause of death was determinable.

Causes and stage of nest failure, or loss of young before independence, where it could be determined, have been as follows (Table 5):

Table 5 - Causes of chick mortality and nest failure at goshawk nests, 1993-1994 in s.e. Arizona

1993:
- 4 of 9 territories (44%) found occupied before laying failed to lay eggs
- 1 of the 9 (site #1020) lost its only chick at about 28 days to probable Great Horned Owl predation
- 1 additional nest, not included in the above 9 (site #1103) had a broken but mostly-whole egg below the nest, which also fledged 2 young. It probably did not develop, as there was yolk on the shell

1994:
- 1 out of 10 (10%) territories found occupied before laying failed to lay
- Nest #4002 failed during incubation. This pair had built a nest on top of an old one. The two were separated by some small limbs, resulting in a double nest, one high, one low. One of the two eggs in the upper (active) nest was out on the side of the nest when I first checked the nest during incubation. It later apparently rolled into the lower nest. It was obvious on climbing that both eggs would have been visible to a landing bird; this dilemma of a double nest each with an egg may have been a factor in the pair's ceasing to incubate.
- 1 of 2 chicks at site #1103 was found dead below the nest at about 10 days of age. The other survived and fledged.
- 1 of 2 chicks at site #3107 died of *Trichomoniasis* within a few weeks of leaving the nest, before either chick was independent. The bird had been dead less than 16 hours when I found it so a successful necropsy was possible.

The finding of death by *Trichomoniasis* at nest #3107 is ominous as the nest was 6 mi. from the nearest town (see further discussion under diet section).

Nests were not climbed until banding, so that other losses of eggs or small chicks may have gone undetected.

I. NESTING HABITAT

Goal # 6 of this project was eliminated, as agreed upon by the Heritage Projects Coordinator. I am reporting here only on features of nest habitats used by goshawks.

Of the vegetative associations used here by goshawks, two are unique to the CNF. Both are in the Madrean Evergreen Woodland One is the Emory Oak Association in which the spring-deciduous Emory oaks form open forests on grass-covered flanks of the mountain ranges. These oak forests are used by goshawks for nesting and probably foraging, as the oak woodlands are a primary habitat for Mearn's Quail, an important goshawk prey species. The

other is the Oak spp.-Chihuahua Pine Association, which forms open stands on stony, dry soils adjacent to riparian areas. The Chihuahua Pine is the most commonly-used goshawk nest tree.

It is interesting that no nests were found in aspens although a special effort was made to search for nests in these trees. The identity of nests trees used by goshawks on the Coronado is presented in Table 6, as well as mean d.b.h. for each species of tree used.

Table 6 - Species of 44 nest trees used by goshawks in southeast Arizona

Tree species	# nests	Mean d.b.h., inches
Chihuahua Pine, *Pinus leiophylla*	15	19
Douglas Fir, *Pseudotsuga menziesii*	8	32
Apache Pine, *Pinus englemanii*	8	20
Emory Oak, *Quercus emoryi*	5	25
Southwestern White Pine, *Pinus strobiformis*	4	23.5
Arizona Cypress, *Cupressus arizonica*	2	26
Ponderosa Pine, *Pinus ponderosa sp*	2	[32[1]]

1. Only one of 2 PIPO trees were measured; not a mean

Nest areas were classified into 5 general physiographic site categories. Their descriptions and the number of nest area in each category are presented in Table 7:

Table 7 - Physiography of goshawk nest areas in southeast Arizona

No. nests	Physiographic Type	Physiographic type Description
14	Riparian	Adjacent to a major drainage (greater than 2.5 mi long)
3	Side canyon	Adjacent to a tributary of a major drainage (less than 2.5 mi long)
6	Terrace	A bench alongside or above but adjacent to a drainage. These sites had a maximum slope of 15 degrees and were within 150 yards of a drainage.
5	Slope	Hillside, not associated with a drainage. These sites had slopes of between 10 and 45 degrees.
3	Oak wood	Low, rolling, grassy hills of Madrean oak woodland

The slopes of goshawk nest areas ranged from 0 (11 of 31) to 45 degrees. The mean of all sites was 13 degrees (s.d. = 13); the mean of those with a slope other than zero was 17 degrees (s.d. =12). The mean aspect for all sites was 155 degrees, and the mean for those with an aspect of other than zero was 211 degrees.

The mean distance to water for these 31 sites was 172 yards, with a range of 2-550. The mean distance to a road or trail was 146 yards with a range of 2 to 1320.

J. DIET OF GOSHAWKS ON THE CORONADO NATIONAL FOREST

The presence of major items in the goshawk diet on the CNF were determined in part from prey remains collected at nests. The use of prey remains, as opposed to data collected from blind observations, to determine raptor diets is a technique fraught with a great many biases and is of minimal usefulness for quantitative diet studies.

Even using prey remains to determine the qualitative nature of goshawk diets is subject to error, the main source being the differential survival of skeletal remains of large, heavy prey as opposed to smaller, lighter-boned prey. Birds the size of and smaller than jays and flickers are important goshawk food, as determined by blind-observation food studies at nests (Snyder, unpub. data and Snyder and Wiley, 1976) (Table 9) and from the fact that their feathers are found at many nests, but they infrequently produce skeletal remains. Pellets I collected at nests occasionally contained the compacted feathers and feet of still smaller birds that had been consumed completely and had left no other trace, either of feathers or skeletal remains, around the nest.

Another source of bias from prey remains is that the number of remains appearing at a site increases when the chicks are about half grown. This may be in part because more food is being brought to the nest, but it is

also due to the fact that the chicks now begin to hold prey and tear meat off carcasses for themselves at around three weeks of age, and they are initially too weak to dismember and break apart skeletal remains that the parents were able to eat, instead leaving them to fall to the ground where they are easy to spot. Therefore prey remains for some size classes of animals from this period of the nestling cycle are probably over-represented. Although after the chicks fledge prey continues to be brought by adults to the vicinity of the nest where it is given to the young, the fledglings feed more and more frequently away from the nest and so prey remains collection becomes more and more difficult.

A prey species was scored for a territory if it was encountered once at a nest. The remains are biased toward those larger species which have at least some heavy bones that survive a feeding; nonetheless, the rather delicate sterna of Mearn's quail were the most numerous single bones encountered.

The distribution of remains by territory, arranged by elevation, is given in Table 8. Remains of 3 individual Cooper's hawks (2 from one nest) were found in prey remains, suggesting that this fellow *Accipiter* may be a regular if infrequent component of goshawk diets.

The two species of quail have very similar sterna, which are the quail bones most frequently encountered under nests. I don't believe I was mistaking Gambel's for Mearn's, because there are 2 little indentations on the dorsal side of the sternum which are consistently larger in Mearn's (checked in multiple museum skeletal specimens). Lesser numbers of quail pelvis/sacrum parts were found and these are very different between the two species. I found Mearn's and Gambel's sacra in the same proportions as I found sterna. Also, I found no Gambel's quail feathers around nests, and frequently encountered Mearn's quail feathers under plucking posts.

Mexican jay remains were found at the high-elevation nest (#4001, at 9000' elev.), suggesting that goshawk are hunting these highly territorial birds well away from the goshawk nest area and at lower elevations.

Elev	Mtns.	Site#	TrSq	RkSq	CtRb	MeJa	StJa	CoHa	NoFl	MeQu	GaQu	BtPi	MoDo	Other	I.d. of other
5200	Huac	3102	X			X				X		X	X	X	Screech Owl
5360	Chir	1006	X	X		X			X					X	Acorn Woodpecker
5450	Pata	3105								X		X			
5600	Pelo	1103				X				X	X	X	X		
5800	Chir	1020		X	X	X	X					X	X		
5800	Chir	1025			X	X	X		X	X			X		
5800	Pata	3107	X	X		X	X		X	X	X	X	X	X	Acorn Woodpecker
5900	Huac	3005	X	X	X	X			X	X	X	X	X	X	
6100	Chir	1030				X	X		X			X	X		
6200	Chir	1008	X	X	X	X	X	X							
6280	Chir	1015			X	X	X	X	X	X	X	X			
6600	Chir	1019			X							X		X	Chipmunk
6700	Cata	5002					X					X			
6850	Huac	3002	X	X		X				X		X	X		
7000	Chir	1018		X	X	X	X			X	X	X	X	X	Hermit Thrush
7400	Pina	4003	X			X	X		X			X	X	X	Hairy Woodpecker
8000	Cata	5007					X					X			
9000	Pina	4001				X	X		X			X		X	Owl, small mammal
6391		Mean													

Table 8 - Distribution of prey remains from goshawk nests by elevation and site # from 6 mountain ranges in s.e. Arizona

MeJa = Mexican jay
StJa = Steller's jay
CoHa = Cooper'shawk
NoFl = Northern Flicker
MeQu = Mearn's quail
GaQu = Gambel's quail
BtPi =band-tailed pigeon
MoDo = Mourning Dove
TrSq = tree squirrel
RkSq = rock squirrel
CtRb = cottontail rabbit

Cottontail rabbit remains were found at nests only late in the nestling stage, and it may have been that mainly the female goshawks are taking these larger mammals once they begin to forage for the brood.

An interesting finding was the discovery of birdseed (whole, undamaged grains of milo and wheat) in multiple pellets from two widely-separated 1994 nests (#3107 in the Patagonia Mts., and #1030 in the Chiricahuas). Presumably the birdseed got into the pellet by being ingested in a crop or gizzard of a bird which the goshawk caught and fed upon. This finding has potential significance to goshawk management, as it may indicate a route by which *Trichomoniasis* may spread to nesting raptors at relatively large distances from the source of infection.

At nest #3107 one of the fledglings died of *Trichomoniasis*, an infection spread by doves at feeders. Neither nest where birdseed was found in pellets was adjacent to human habitation where birds were being fed; #3107 is 3 mi. from the nearest regularly-occupied ranch house and 6 mi from a town. This pair fed on mourning doves which leave their nesting areas to move long distances to water (Brown 1989), and the infection may have traveled away from town with the doves which were then caught by the goshawks. Approximately 20% of Arizona mourning doves are infected with *Trichomoniasis* (Straus,1966).

Pair#3107 also took quail and jays, both of which visit bird feeders. Territory #1030 is 1.5 miles from the nearest habitation where birds were being fed, well within the foraging range of goshawks.

Observations from full-day watches from blinds at three Coronado goshawk nestings in 1969, 1970 and 1971 resulted in 59 prey deliveries of which 97% were birds and 3% were mammals (Table 9). These food records are from the incubation period as well as nestling. Site #1008 was in the Chiricahuas, at 6000' elevation and #3102 was in pine-oak woodland in the Canelo Hills area at 5200' elevation. Interestingly, only 1 quail was recorded as goshawk prey in these years. It was a time of drought, with little grass cover, and Mearn's quail sightings were rare in these years.

Site #3102 was also represented in the 1992-94 prey remains collections; site #1008 was not active in the years I collected prey remains.

Table 9 Prey records from blind observations at 3 southeast Arizona goshawk nests, 1969-1971. Source of data: Snyder unpub. data and Snyder and Wiley, 1976.

Prey species	Site # 1008/1969	Site # 1008/1970	Site # 3102/1971	Totals
Birds				
Quail			1	1
Mourning dove		2	1	3
Dove-sized bird		1		1
Band-tailed Pigeon	8	1		9
Mexican Jay	5	7	5	17
Unident. jay	2	4	2	8
Jay-sized bird		1	2	3
Robin-sized bird		1	3	4
Unident. bird		2	2	4
Small bird		1		1
Nesting bird		2		2
Acorn Woodpecker			1	1
Northern Flicker	3			3
Mammals				
Rabbit			1	1
Mammal			1	1
Site totals	**18**	**22**	**19**	**59**

Birds = 97%, mammals = 3 %

Coronado goshawks are different from goshawks elsewhere in the U.S. in that at middle and low elevation nests in some years they apparently make heavy use of quail. Although as stated above prey remains do not lend themselves to accurate quantification, it is still meaningful that quail were the commonest remains during the years of the study, with 56 individual represented totaling 25% of all remains. 80% were Mearn's quail, a species unrecorded for goshawks elsewhere in Region III. We recorded 1 quail out of 59 deliveries at nests on the CNF in 1969-1971 (Table 9). Boal and Mannan (1994) did not report quail in their diet study involving 385 prey deliveries observed from blinds on the Kaibab National Forest in northern Arizona.

Quail are clearly important to Coronado goshawks, at least in some years.

This difference in diet from more northerly birds is potentially important in management; the Management Recommendations for the goshawk in the Southwestern United States (USDA 1992) did not include quail as one of the 14 species considered important for goshawk, and for which habitat is to be managed.

K GOSHAWK NUMBERS

There is some circumstantial evidence that goshawk numbers on the CNF may have declined in the last 10 years. This may be because of an absolute decline, or it may be that they fluctuate somewhat regularly on some as-yet undefined schedule. There are two lines of evidence for this possibility:

1) During the early part of this study and for several years before, I found 5 territories that initially had inactive, classic goshawk nests in good condition, which as the decade progresses have been aging together into disrepair and disappearance (Table 10). These areas have not had recent goshawk nesting activity within1.6 mi. This suggests that in the late 1980's or early 1990's there were nesting areas active that are not now.

2) There were records for 15 active goshawk territories in the late 1980's and early 90's, in addition to ones still active in the study years; in 1992-1994 I have been unable to relocate signs of goshawk activity within 1.6 mi. of any of these, other than at 3 where single males have been observed. I have been unable to locate old nests at 11 of the 15, despite intensive nest searches. This suggests that these areas were active in the late 1980's but are no longer.

TABLE 10 - Territories which were known to be active in the late 1980's- early 90's but which have not been occupied 1992-1994 except as noted

Site #	Evidence for late 1980's activity
1-003	Reports from others of nest and chicks, 1956 to late 1980's
1-004	Report of pair calling and displaying, late 1980's
1-005	Territory active at least 1986, 1988 and 1990
1-006	Recently-used nest and abundant skeletal prey remains when discovered in 1988
1-008	Nest active in 1988; failed. Single birds present in some intervening years; male present in 1993
1-012	Solid , recently-used nest when found in 1990
1-013	Tom Deecken/USFS reported fledglings in 1988; old nest still present
1-016	Solid classic goshawk nest, many scattered skeletal prey remains when found in 1991
1-017	Tim Tibbetts/AGFD had fledglings in 1991, no nest located
1-019	Report of active nest in 1980's; one of the alternate nests has been occupied by Coopers 1992-1994, but it had fresh goshawk-thickness eggshell below it when found in 1991, also many large skeletal prey remains
1-021	Nest active in 1980's and earlier, many records
1-026	Tim Tibbetts/AGFD had fledglings in 1991
1-028	Reports of active nest in late 1980's (Rick Taylor, Portal; Sally Spofford, Portal)
1-029	Classic goshawk nest found in winter of 1993-1994; active with Coopers 1994
2-002	Russell Duncan had birds calling here in 1991
3-004	Nest was active here in late 1980's (AGFD Heritage database, other sources)

It could be argued that this does not represent a change in numbers, but is only the result of a general shift in nest-area locations. Most breeding populations of raptors maintain a relatively constant spacing of territories over time with similar nest densities from one year to the next in a given habitat, while in some species the physical locations of nest areas may change over time (Newton et. al, 1986). For example, Cooper's hawks in the mountains of southeast Arizona nest about 1 mile apart in good habitat, but the actual locations of nest area shifts over time, so that nest areas in the 1990's are now located midway between where nest areas were in the 1970's.

Raptor species which do not do this are typically more nest-site limited, such as large falcons (peregrine and prairie) and golden eagles in areas of few suitable cliffs. Goshawks on the Coronado for the most part follow this latter pattern. Goshawk nesting habitat on the CNF is limited because it is

typically located in canyon bottoms and is primarily determined by physiographic parameters such as the confluence of drainages,where soils are deeper, the terrain is flatter and presumably underground water supply permits the largest trees to grow. Of 8 goshawk territories on the Coronado which I visited during the 1970's 6 of 8 are still active within a few hundred yards of their original location, and there has been no activity at others within 1 mi.

Goshawk populations in some areas fluctuate regularly, responding to changes in the prey base such as the 10-year snowshoe hares cycle in the arctic (Doyle and Smith 1994). This phenomenon is more pronounced in northerly parts of the species' range. Less regular and predictable changes in goshawk numbers and productivity occur at more southerly latitudes, for example in 1993 when most goshawk studies in the western US reported very low productivity (S. MacVean, pers. com)

If there have indeed been changes in the past 10 years in goshawk numbers on the Coronado, one possible cause is that the apparent peak in active territories in the late 1980's is related to higher numbers of quail in in some years than in others. Quail numbers are greatly influenced by early winter rains (Brown, 1989), the winter of 1983-1984 was very wet and quail are used heavily by Coronado goshawks in some years and almost not at all in others (see diet section, this report). There may therefore have been a peak year or two of quail, and therefore goshawk, reproduction following the 83-84 El Nino, and the birds produced then resulted in an increase in breeding pairs in the following 5-6 years. 1993 was a bad year for goshawks everywhere in the west except for on the Coronado, when goshawk productivity and numbers of quail in the diet were the highest for which I have records. It should be possible to examine this hypothesis further, as the 1994-1995 winter promises to be another with good timing and amounts of rain for quail production, which may lead to another year of high goshawk reproduction.

Undoubtedly the total carrying capacity of the CNF for goshawks has fluctuated in the past 100 years. In some parts of the forest it has probably decreased (such as in the high country of the Pinalenos), as fire protection leads to increased thickets of young trees, fuel buildup (Marshall, 1957) and ultimately catastrophic wildfire that severely alters or destroys large amounts of habitat for many decades into the future, such as occurred in the

Chiricahuas in 1994 and the Huachucas in 1977. J. T. Marshall (pers. com.) feels that fire control has led to a decrease in habitat quality for many species on the Coronado, as compared to the ecologically similar mountain ranges immediately south of the U.S.-Mexico border.

Not all change has been for the worse. Areas which were logged for mine timbers or occupied by miners in the early part of this century have regenerated, and some current goshawk nest areas are located in regrowth at or near old mine and town sites which were probably vastly different 90 years ago.

MANAGEMENT RECOMMENDATIONS

As part of this project I have interacted extensively with CNF wildlife and range staff in response to their request for comments on a number of proposed activities that CNF personnel felt might affect goshawks during 1993-1994. This included input into the Draft EIS for a proposed amendment to 10 National Forest plans in Arizona and New Mexico, commentary on plans for the Twilight Campground development and related matters, input into timing of seasonal closures and site-specific recommendations for protection around active goshawk nest sites during management activities I have made site-specific recommendations for each recently-active site on the CNF which warrants such attention (Appendix V).

From the habitat data presented it can be seen that most known goshawks on the Coronado nest close to areas of human activity, such as road or trails; the mean distance was 146 yards, and if one site at 1320 yards is excluded from the calculation the mean drops to 116. This proximity is because goshawks generally nest in the largest trees, which grow in and near riparian areas, the same areas that are the sites of trails, road, campgrounds and homesteads in these steep mountains. This is a source of past and potential future of conflict between people and birds, and it needs to be addressed.

Specific forest management recommendations are:

1. Identify those active territories that are the source of recruitment breeders into the population. This study and the work of CNF biologist have

provided a set of historical and recently-active territories to work with. Further research needs include marking young produced and tracking their survivorship and breeding history. The territories that produce survivors who consistently enter the breeding population are worthy of more management effort than those that do not.

2. Define nest areas, PFAs and foraging areas for future active nests. This will require a territory-by-territory assessment similar to what I have done during this study and under other contracts with the CNF. Foraging areas should be studied via radio telemetry of adults.

3. Adopt formal CNF guidelines for timing of closures near occupied territories and protecting active nests from human disturbance and adverse management activities. My recommendations are: Closure Feb. 15-Sept. 1, and maintain minimal human presence within .3 (minimum) to .5 mile of an occupied nest. Distance can be adjusted according to vegetation density and terrain: the smaller distance is acceptable at territories which are heavily forested or steeper and less accessible to humans, which are generally those at higher elevations. The .5 mile distance should be used for more open, generally drier and lower elevation nest territories. The goal is to produce a visual and auditory buffer for the goshawks.

4 3. Evaluate habitat characteristics of nest stands and foraging areas used by southeastern Arizona goshawks and use data to manage habitats by thinning or controlled burns. The goal should be to assure the sustainability of forest conditions utilized by goshawks in southeast Arizona.

5 4. Manage for Mearn's Quail in Madrean evergreen woodlands by controlling percent grazing utilization to recommended levels, generally less that 45%. Mearn's Quail are extremely sensitive to loss of grass cover (Brown, 1989). Mearn's Quail are important to goshawks in southeastern Arizona.

6. In planning fuelwood cuts in evergreen oak woodlands, inventory first for Accipiters. Do not cut so as to thin or open up the canopy of large closed-canopy groves of oak, but instead remove understory trees if it is necessary to cut in groves at all. Avoid canyon-bottom sites altogether, cut oak away from the areas of largest trees.

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ENGLISH AND SCIENTIFIC NAMES OF PLANTS AND ANIMALS MENTIONED IN REPORT

PLANTS

Arizona Cypress	*Cupressus arizonica*
Apache Pine	*Pinus englemanii*
Aspen	*Populus tremuloides*
Chihuahua Pine	*Pinus leiophylla*
Douglas Fir	*Pseudotsuga menzeisei*
Emory Oak	*Quercus emoryi*
Ponderosa pine	*Pinus ponderosa* var. *arizonica*
Southwestern White Pine	*Pinus strobiformis*

BIRDS

Acorn Woodpecker	*Melanerpes formicivorus*
Band-tailed Pigeon	*Columba fasciata*
Common raven	*Corvus corax*
Cooper's Hawk	*Accipiter cooperi*
Gambel's Quail	*Callipepla gambelli*
Great Horned Owl	*Bubo virginianus*
Hairy Woodpecker	*Picoides villosus*
Hermit Thrush	*Hylocichla guttata*
Mearn's Quail	*Cyrtonyx montezumae*
Mexican Jay	*Aphelecoma mexicana*
Mourning Dove	*Zenaida macroura*
Northern Flicker	*Colaptes auratus*
Prairie falcon	*Falco mexicanus*
Peregrine falcon	*Falco peregrinus*
Red-tailed Hawk	*Buteo jamaicensis*
Steller's Jay	*Cyanocitta stelleri*
Western Screech Owl	*Otus asio*
Zone-tailed Hawk	*Buteo albonotatus*

MAMMALS

Abert's Squirrel	*Sciurus aberti*
Apache Fox Squirrel	*Sciurus apache*
Arizona Gray Squirrel	*Sciurus arizonensis*
Chipmunk	*Eutamia dorsalis*
Cottontail rabbit	*Sylvilagus floridanus*
Rock Squirrel	*Citellus variegatus*